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3 JUNE 1956

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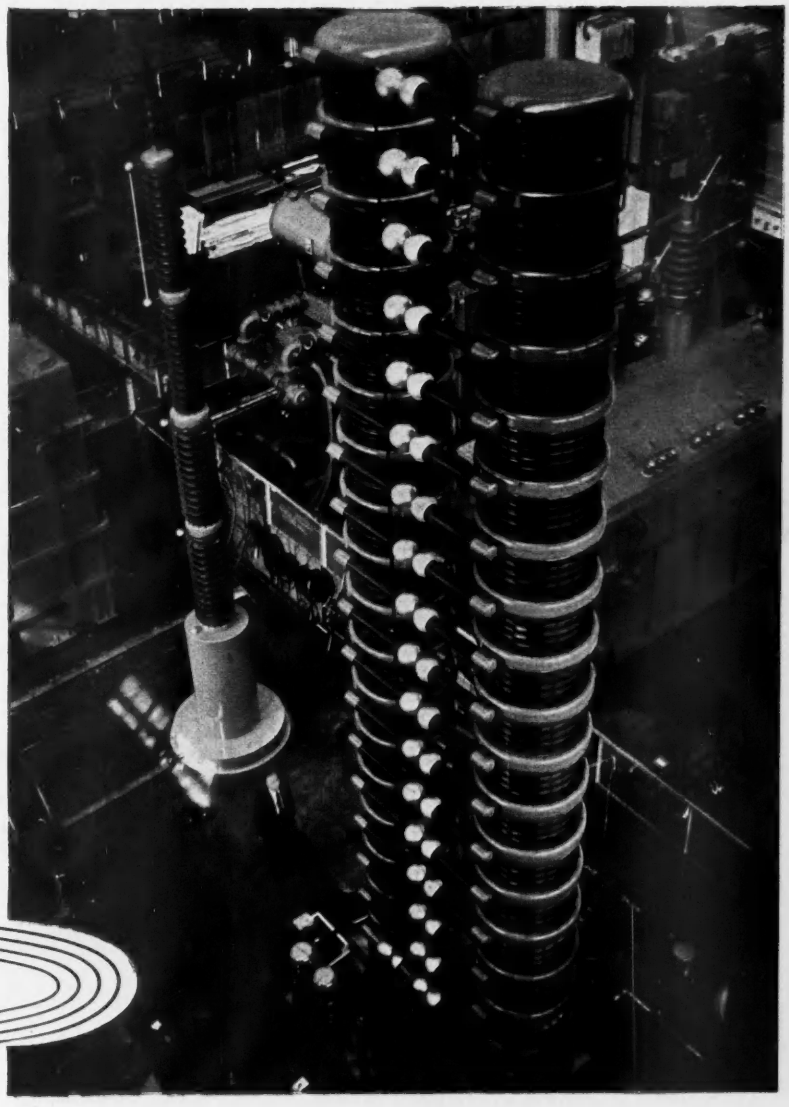

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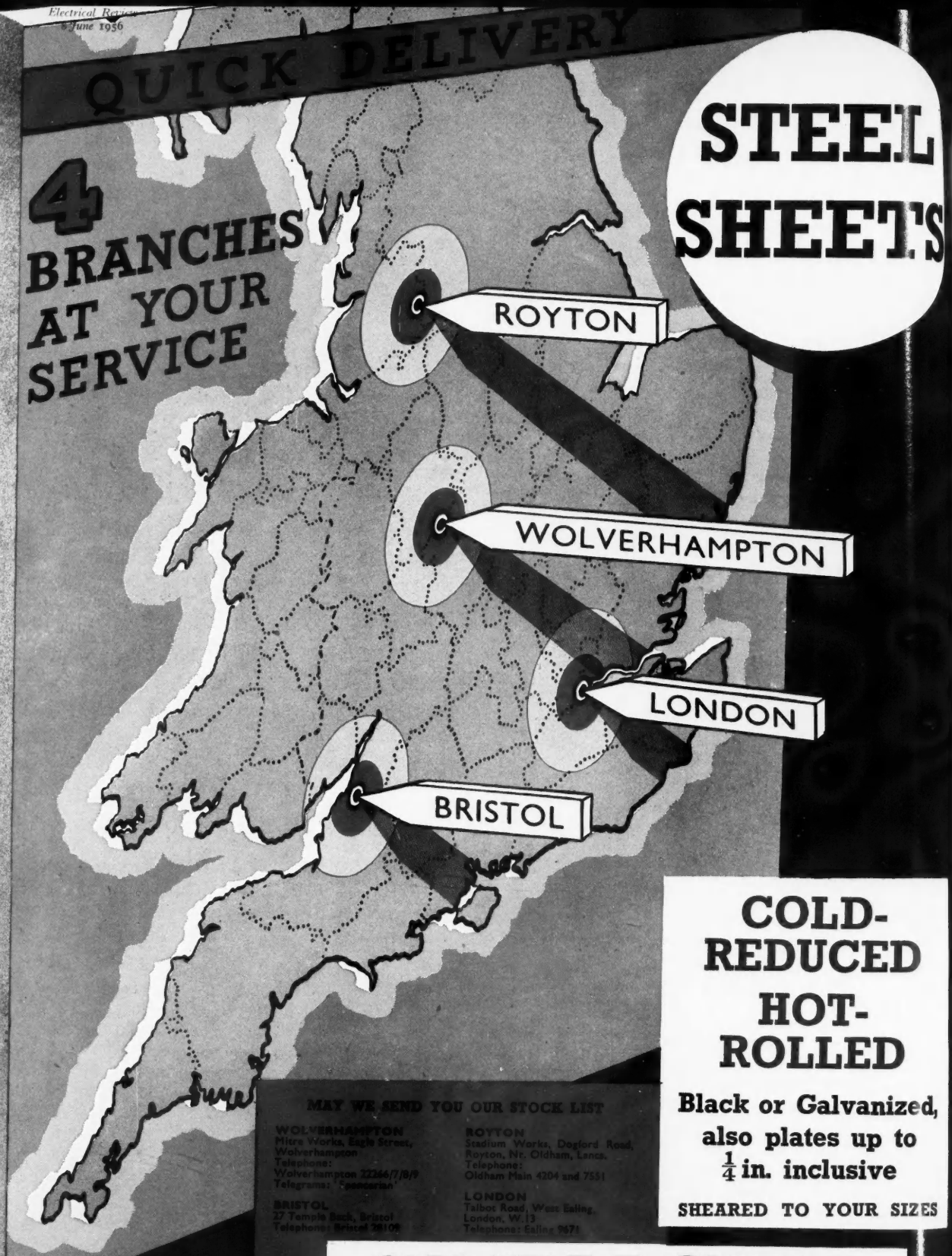

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8 JUNE 1956

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ELECTRICAL REVIEW

8 June 1956 Vol. 158 No. 23 Established 1872

Ever Higher Voltages

SOME justification for the view that transmission voltages are likely to follow, for some time at least, the trend of doubling every twenty years or so is to be found in the papers discussed at C.I.G.R.E., a first report on which appears in this issue. It has been made quite clear that even 220 kV (let alone 110 to 160 kV) is regarded by engineers of leading industrial countries as inadequate to cope with electrical loads of only a few years hence as well as with greater transmission distances, having regard to the complexities of system stability. At higher voltages, too, the reduction in the number of circuits made possible will lessen obstacles to finding routes, especially over difficult terrain. Such considerations underlay the decision taken in Britain about seven years ago to erect the 275 kV supergrid, with provision for converting sections of it to 380 kV as soon as circumstances make this course economically desirable.

The wisdom of this adaptation of the old maxim " when in doubt, go for the higher voltage " is confirmed by plans in active preparation abroad, where overhead lines are now under construction or, as in Sweden, in use at the higher voltage. Moreover, in some instances existing 220 kV lines are being reconstructed for 380 kV. The use of the latter answers the question of the most satisfactory method of earthing the system neutral in favour of a solid connection, which was adopted for the 132 kV British grid nearly thirty years ago.

It seems that expenditure on apparatus does not rise exponentially with voltage, as was once feared (rather the contrary) and that such devices as bundle conductors and series capacitors may materially raise current-carrying possibilities. Working to closer limits to secure economy has not depreciated reliability, which reaches at least as high a standard as it did, say, half a century ago, when the electrical stresses involved in transmitting energy over a few miles were but a very small fraction of those that are imposed nowadays. Three-phase transmission at 650 kV is envisaged as an ultimate possibility, at which point, or earlier, progress in direct-current technique may be far enough advanced to become a major factor in developments. Many snags will, no doubt, be encountered. Approach to the greater problems of the future appears to be more sanguine than ever, but not more so than is warranted by the results now being achieved, snowball fashion, in research, both fundamental and applied, backed by deductions drawn from practical experience over long years of evolution to the present stage not only here but also in other countries through international discussions such as those taking place in Paris.

INSTALLATION INSPECTION

Approval by the Board of Trade of the formation of the National Inspection Council for Electrical Installation Contracting marks the institution of a scheme which has been under discussion for nearly seven years. As far back as November, 1949, an Organising Committee, representing the various bodies interested in installation work, was set up and a report was presented in May, 1951, in which the Constitution of the proposed Council was outlined. It was not until May last year that a tentative National Inspection Board was actually formed. The long delay seems to have been due largely to the desire of some of the members of the Organising Committee that registration and inspection should be compulsory not voluntary.

The new Inspection Council will set up a roll of approved contractors and, initially, these will consist of members of the contracting departments of Electricity Boards, members of the Electrical Contractors' Association and of the E.C.A. of Scotland, and those on the list of the National Register of Electrical Installation Contractors. In getting going the Council will have the benefit of the more than thirty years' experience of the N.R.E.I.C. which will form some sort of nucleus for the new scheme.

FUMELESS VEHICLES NEEDED

On the report stage of the new Road Traffic Bill Mr. R. Bell sought to add a clause prohibiting the use of diesel engines on public roads in the Metropolitan Police District from 1st January, 1965. The rejection of the clause was, of course, a foregone conclusion but it gave Mr. Bell and Mr. Palmer an opportunity of making a further protest against London Transport's decision to replace 1,800 trolley-buses by diesel-engined vehicles. It was a little ingenuous of Mr. Molson, Parliamentary Secretary to the Ministry of Transport, to suggest that there was no evidence that exhaust fumes from diesel engines had any measurable effect upon those who inhaled them. Mr. Bell said that the argument seemed to be that 2,000 more diesel vehicles could not worsen a condition already so bad.

The facts remain that trolley-buses make less noise, emit no fumes, are independent of imported fuel and in many areas are no more likely to cause traffic congestion than other vehicles. Is it yet too late for London Transport to alter its unfortunate decision?

UNIVERSITY RESEARCH

It is now almost exactly eighty-two years since the Cavendish Laboratory, Cambridge, was opened for the purpose of teaching experimental physics. In an article which is published in this issue the subsequent growth of the Laboratory is described and a survey is made of some of the investigations which are being carried out in various fields. For many years now the Cavendish has been pre-eminent in the field of physical research, particularly in connection with nuclear physics. In fact we might go so far as to say that nuclear physics originated in the Laboratory when the electron was discovered in the middle '90s during the time when J. J. Thomson was in the chair.

Since then a great deal of ground has been covered and international fame has been achieved by a large number of Cavendish research workers. To-day research students come from almost every university in the world to work alongside post-graduate students from Cambridge itself. But nuclear physics is not the only line of research which is being pursued at the Cavendish. Much valuable work has been and still is being done in such fields as biology, electron microscopy, low temperature physics, and radio-astronomy. Comparatively speaking, it is not long since the need for teaching experimental physics became anything like generally recognised in this country, and as a nation we are not as well equipped in this direction as we should be to compete with the United States and Russia. There is no doubt that all the money which has been spent at the Cavendish has been more than repaid in terms of ideas and inventions and higher quality scientific manpower.

DEMAND ANTICIPATED

Employers in the engineering industry have not waited for the formal presentation of the trade unions' demand for a further increase in wages. They have announced in advance that in the light of the national inflationary position and having regard to the increases granted last March any further wage demands will be rejected. They have agreed, however, to discuss claims for longer holidays and a shorter working week and also to consider the unions' proposal for an inquiry into the position of women in the engineering industry.

The employers' attitude is justified although there are possibilities of severe trouble in their decision. Mounting export prices resulting from inflation in this country are likely to do great damage, not the least to many employees in the engineering industries who will ultimately be "redundant" if we cannot sell our products.

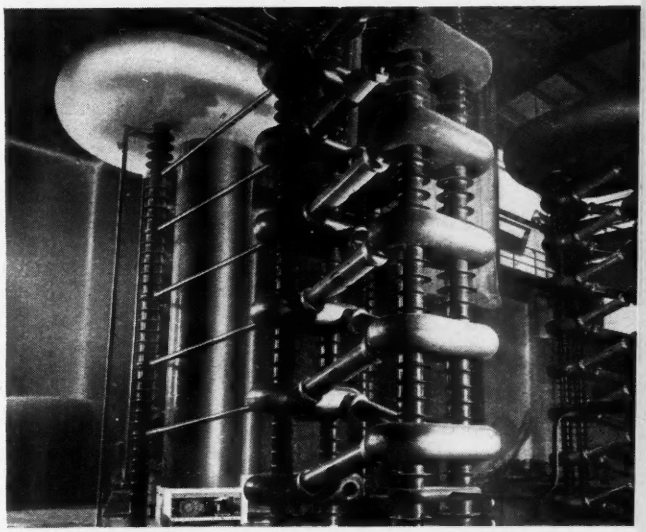
ENGINEERING DESIGN

Some interesting ideas developed in the lecture given to the Institution of Electrical Engineers by Sir Gordon Russell on "Appearance Design." One seems to have been that design engineers should go on a short course as part of their training, mixing with artists to understand their principles of design and the idiom in which they work. Such a course would seem to be one with somewhat problematical benefits. To those of us who regard with a layman's bewilderment some of the creations on canvas at exhibitions, the impact of certain influences on engineering design could be truly startling.

However, one of the papers presented to the conference organised in conjunction with the Production Exhibition at Olympia recently, by Mr. J. Barnes, gave us a better perspective on the subject of industrial design, and some excellent illustrations of how, in the hands of one trained in art but deeply versed in manufacturing techniques, products more satisfactory both æsthetically and practically, could result. Lower production costs might even be achieved also; and the very close collaboration necessary between designer and client was stressed time and again. On balance it would seem that this is a better line of approach and all manufacturing concerns should be encouraged to invest in better appearance design.

Cavendish Laboratory

HISTORICAL NOTES AND SURVEY OF CURRENT WORK



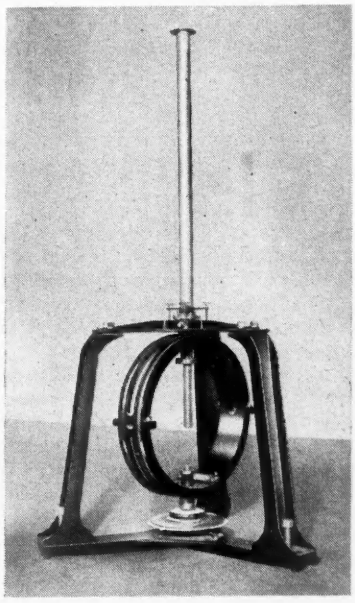
THE need for teaching experimental physics at Cambridge was first formally recognised in 1869 when a report of a syndicate recommended the appointment of a professor and a demonstrator, and the provision of a lecture room, laboratory, classrooms and a stock of apparatus. Two years later James Clerk Maxwell (1831-1879) was appointed to the Chair and apart from giving lectures he devoted much time and care to the planning of the Laboratory and the selection of apparatus.

The first building was formally opened in 1874 by William Cavendish, 7th Duke of Devonshire, who was then Chancellor of the University of Cambridge. After Maxwell's death in 1879 it was decided that the Professorship should be continued and Lord Rayleigh (1842-1919) was appointed. During the following year W. Napier Shaw (later Director of the Meteorological Office) and R. T. Glazebrook (later Director of the National Physical Laboratory) were appointed as demonstrators and with their assistance Rayleigh did much to establish the teaching of practical physics on modern lines.

During ensuing years the growth of the courses necessitated a considerable expansion of the Laboratory facilities. For instance, the workshop set up by Maxwell was enlarged to cater for the increased demands of teaching and research. Rayleigh's investigations at this time were concerned with the increase in precision in electrical units which was being demanded by the needs of the time. His determinations reduced the uncertainty from about 3 per cent almost to the present high standards of accuracy and reproducibility. This resulted in the Laboratory becoming a centre for the establishment and maintenance of such standards until the subsequent foundation of the National Physical Laboratory. In 1884 Rayleigh resigned and was succeeded by J. J. Thomson (1856-1940), the most fruitful period of whose tenure was the middle 90's, when atomic physics was inaugurated by the discovery of the electron.

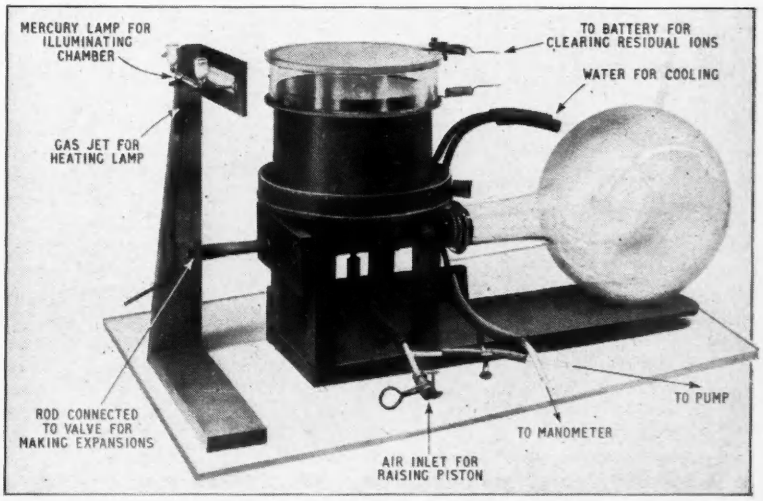
In 1895 a change was made in the University regulations which had a far-reaching effect on the destiny of the Laboratory. This change enabled graduates of other universities to come to Cambridge as research students, and since that time the Cavendish has contained a band of such people from almost every university in the world, all working at the side of post-graduate students from Cambridge itself.

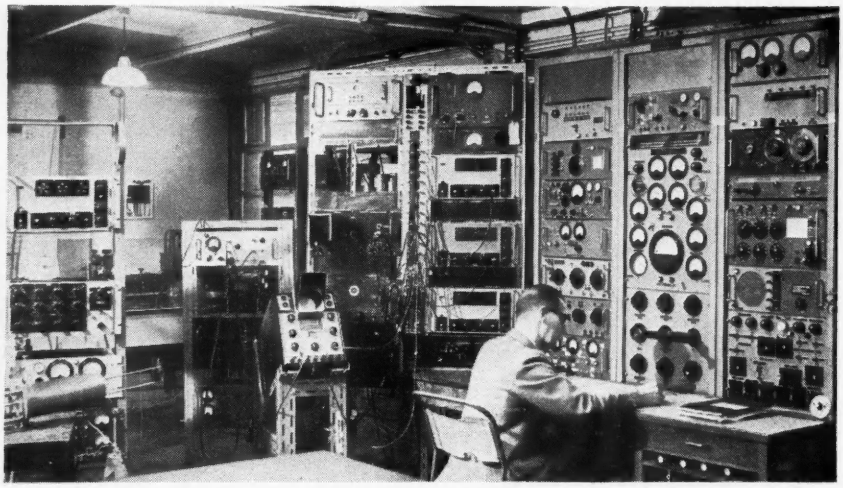
During this period the Laboratory became the centre of the first large research school in this country and achieved international fame from the galaxy of distinguished



Left: Rayleigh's apparatus for the accurate determination of electrical units

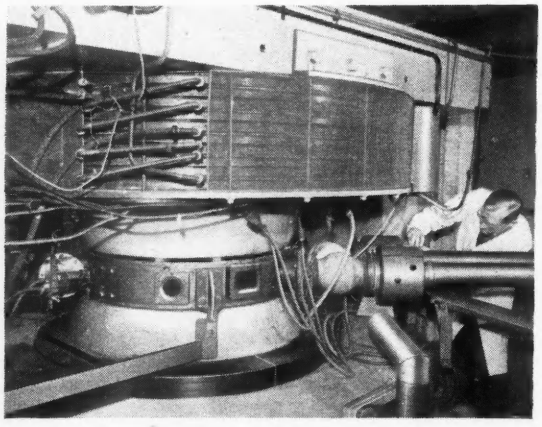
Below: Model of Wilson's original cloud chamber apparatus


MERCURY LAMP FOR ILLUMINATING CHAMBER
TO BATTERY FOR CLEARING RESIDUAL IONS
WATER FOR COOLING
GAS JET FOR HEATING LAMP
TO PUMP
TO MANOMETER
ROD CONNECTED TO VALVE FOR MAKING EXPANSIONS
AIR INLET FOR RAISING PISTON



Main control panels for one of the high-voltage particle accelerators in the Nuclear Physics Section

This 36in cyclotron was one of the first constructed in Europe



physicists presided over by Thomson. These included Rutherford, Townsend and Langevin, to mention but a few. In 1911 C. T. R. Wilson constructed something which has perhaps had more influence on the development of atomic physics than any other single piece of equipment —the cloud chamber.

Lord Rutherford (1871-1937) became Cavendish Professor in 1919 when he was at the height of his career. His first research after his appointment confirmed the disintegration of nitrogen nuclei by alpha particles. In 1932 Sir James Chadwick discovered the neutron and in the same year Sir John Cockcroft in collaboration with E. T. S. Walton first achieved the disintegration of nuclei by artificially-accelerated particles. Their apparatus marked the beginning of a new era in the construction of large equipment for physical experiments. The Mond Laboratory, which forms part of the Cavendish, was completed in 1933 under the direction of P. Kapitza, one of the pioneers of low temperature physics in this country. At the same time Sir Edward Appleton was contributing much in the field of radio physics. In 1936 the late Lord Austin paid a tribute to Rutherford and his colleagues by giving £250,000 to provide further buildings and equipment. Plans for a new wing to the Laboratory, now known as the Austin Wing, were completed before Rutherford's death in 1937, but the actual building was not started until 1938, the year when Professor Sir Lawrence Bragg was appointed to the Chair. The building was completed in June, 1940, and a large proportion of it was immediately requisitioned for Government research, so that it was not until 1945 that the normal work of the Cavendish could be resumed.

At this stage and for the following four or five years Professor Bragg was involved in a large-scale programme of reorganisation entailed by the new accommodation becoming available, which made it possible to increase the size of the research school. Since then there has been a big demand for places in the research schools in the Cavendish. During the immediate post-war period many graduates wished to return after war service to continue their careers and the needs of industry and Government Departments for physicists trained in research methods became an urgent national requirement.

During the post-war expansion the old tradition of having a proportion of overseas students undergoing courses of research was maintained and still continues. About one-third of the research students working in the Laboratory fall into this category. Because of the large numbers of such students, the varied interests of the research and the many directions in which research in physics has developed, the policy since the war has been to widen the field of research activity, with the result that the Laboratory is now divided into the following research sections:—Nuclear physics, ionospheric physics, radio astronomy, meteorological physics, low temperature physics, electron microscopy, X-ray crystallography, fluid dynamics and theoretical physics.

Organisation of the Laboratory

To allow the Cavendish Professor, in addition to his duties in teaching and research, to concentrate on scientific policy, an administrative officer, the Secretary to the Department of Physics, has been appointed to be responsibe for assistant staff and buildings and to deal with the business side of the Laboratory generally. The Professor's link with each research section is through the head of the section, who is a senior member of the teaching staff and the leader of the research work of the section. Each section is a self-contained unit with its head, a team of members of the teaching and assistant staff, a secretary/shorthand typist, and the research students undergoing post-graduate training. Included in the accommodation allocated to each section are research rooms which provide both bench and desk space, and a workshop. A number of central services are provided for the general benefit of all sections. These include a large main workshop which undertakes major constructional work, a students' workshop where research students can learn to use machine tools, a central store which keeps large stocks of apparatus such as valves, resistors, capacitors, wire, glassware, etc., and an electrical maintenance department. In addition, there are two libraries, a colloquium room and a conference room.

The membership of the present-day Laboratory is made up as follows:—Teaching staff 33, research students 100, research assistants 20 and assistant staff 86, including

clerical staff, laboratory assistants and mechanics. Apart from these there are usually about 20 senior research workers visiting the Laboratory for periods of up to a year, the majority of whom are members of the staffs of overseas universities spending study leave in Cambridge. In addition, all undergraduates at the University reading physics attend the Cavendish for lectures and practical work in the class laboratories. About 550 such students have to be accommodated, of whom about 90 are specialists reading Part II of the tripos in physics. The accounts for the Laboratory for the financial year ended 31st July, 1954, show that the average annual cost to the Laboratory of providing a research student with the amenities he requires is £750, excluding the maintenance allowance or scholarship awarded to the student to meet his living costs. The average maintenance allowance made to a student is £450 per annum so that this, together with the cost of maintaining a student in the Laboratory, means that every research student at the Cavendish costs the community about £1,200 per annum.

To complete the historical picture it must be recorded that Professor Bragg resigned from his post in December, 1953, when he left the Cavendish to take up his appointment as Director of the Royal Institution in London. Professor N. F. Mott, formerly Director of the H. H. Wills Physical Laboratories at the University of Bristol, is now the Cavendish Professor, having taken up his duties in August, 1954.

Radio Research

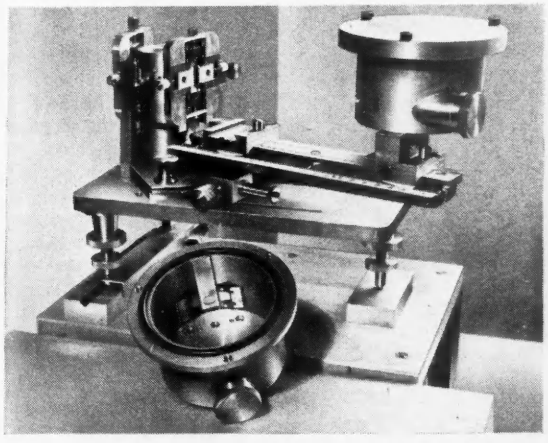
Having dealt with the history and organisation of the Laboratory it may be of interest to describe briefly some of the work which is at present being conducted by research students in the individual sections. In the Radio Section, for example, use is being made of radio waves to study the physics of the upper atmosphere and to investigate the radio-frequency radiation emitted from astronomical bodies. The ionised part of the upper atmosphere, the ionosphere, is capable of reflecting radio waves of suitable wavelength. By studying these when they are returned to the earth deductions are made regarding the existence of irregularities in the upper atmosphere, and regular drift movements of these irregularities. The movements are caused, at least in part, by electromagnetic forces and their study leads to information about those forces. The researches in this field involve the extension of optical diffraction theory to cover the case where the diffracting object has an irregular structure and the theory of random electrical noise has been adapted for this purpose.

Other experiments are concerned with the lowest part of the ionosphere which is being studied by means of waves of long and very long wavelengths. For this purpose use is made of existing commercial sending stations and special receiving equipment is employed to derive information about the amplitude, phase and polarisation of the downcoming reflected waves. In the associated theoretical work much use is made of the electronic digital computer in the University Mathematical Laboratory. With its aid the propagation of long and very long waves is being investigated theoretically for comparison with the results of experiments.

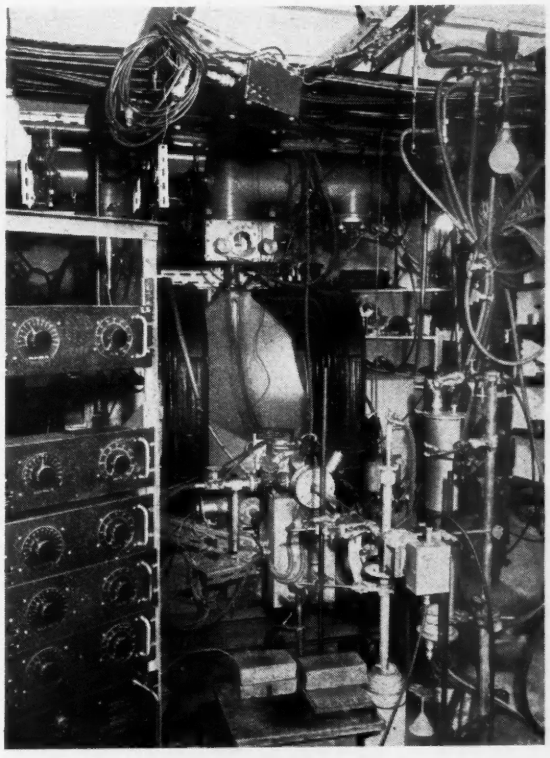
In another section of the work an attempt is being made to derive new information from a part of the very large quantity of results which are produced by the ionospheric observatories distributed over the world. By using new methods of analysis it has been possible to make new suggestions about how the ionisation in the F layer, at a height of about 300 km, is produced and lost.

Nuclear Physics

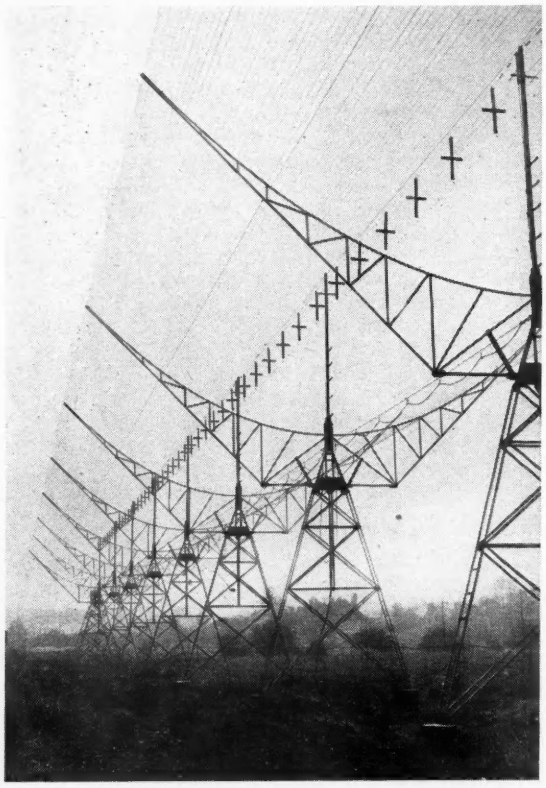
The work of the Nuclear Physics Section dates back to the famous investigations of Rutherford and is, in fact, a continuation of the work started when Cockcroft and Walton built their first particle accelerator in 1932. It was then found possible to study the well-defined excited states which light nuclei possess, and much work during the next years went into determining their precise position on the energy scale. It was under Rutherford's influence that three of the present accelerators were built in the middle 30's; two h.v. sets of the Cockcroft-Walton type constructed by Philips and a 36in cyclotron, one of the first in Europe. Since the war an electrostatic generator has



This X-ray diffraction camera is a typical example of the high class of workmanship in the Laboratory workshops



Target end of the English Electric–Van de Graaf generator



Part of the aerial system used by the Radio Astronomy Section

been built by the English Electric Co., Ltd. Operating at present at about 2·5 MeV, it is designed to produce energies up to about twice as much, but the necessary improvements to the accelerating tube have not yet been made.

Most excited states of the light nuclei up to, say, sodium, and up to several MeV excitation energy have by now been accurately located. But in order to check those states against nuclear theory one also needs their more subtle characteristics, in particular their spin and parity. Spin, according to quantum theory, is restricted to integral multiples or half-integral multiples of $h/2\pi$, depending on whether the nucleus in question has an even or odd mass number. Parity is a symmetry characteristic of the nuclear wave function usually described as "odd" or "even," depending on whether the wave function changes or does not change sign when all co-ordinates are reversed.

The methods for determining spin and parity depend largely on studying the angular distribution of the particles emitted, and much of the current work is of that kind. The angle can refer either to the direction of the incoming bullet or to that of another outgoing particle; in the latter case one speaks of the angular correlation between two outgoing particles, one of which (or both) may be a gamma quantum, a photon of high energy.

Recently, the techniques employed in studying these phenomena have greatly increased in complexity and power. In particular, the introduction of scintillation counters has made it possible to select, of all the photons emitted in a nuclear process, those of a given energy, and that has greatly improved the ease with which complex nuclear disintegrations can be unravelled. In this work the Section has had much help from improved electronic equipment designed in its own workshop, in particular from a pulse height analyser or "kick-sorter" by which pulses arriving at a rate of 100 a second or more can be sorted into 120 channels according to their amplitude, with great accuracy. The very rapid response of scintillation counters also makes it possible to time events to about 10^{-8} sec, a device by which, for instance, photons and neutrons can be distinguished by their different time of flight over distances of a few feet.

By using these methods, the Cavendish Laboratory has made a substantial contribution to the knowledge of the structure of light nuclei and done much to confirm some of the basic ideas of current nuclear theory, in particular, the idea of charge independence (the independence of the nuclear force between two particles of whether one or both carry an electric charge).

A separate group studies nuclei by an entirely different method. This is an extension of Rabi's atomic-beam method for measuring nuclear spins and the associated magnetic moments. In the Cavendish, the workers have specialised on radioactive nuclei which, because of their small abundance, are particularly difficult to study. It is a large field, and attempts are being made, by developing new methods of measuring the beam, to extend it to elements previously not accessible. The recent determination of the spin of radium E has settled a controversy of long standing, and its magnetic moment is at present being measured. In this connection it may be mentioned that an experiment has been started by which it is hoped to measure the magnetic moment of free electrons with an accuracy of one part in a million.

Radio Astronomy

The work of the Radio Astronomy Section is particularly interesting since a turning-point has been reached in the study of "radio-stars" (celestial sources of radio emission), the first of which was discovered eight years ago. These sources, which have been called "dark stars" because of the difficulty of finding visible objects in their positions, constitute one of the great mysteries of post-war astronomy. In 1952, as a result of more accurate positional measurements, faint optical objects were found by Dr. Baade, using the 200in telescope at Mount Palomar, in the positions of the two most intense radio stars; one was a most unusual gaseous cloud situated in the Milky Way system at a distance of about 10,000 light years; in the other, the radio emission was found to be the result of a collision between two extremely remote extragalactic nebulæ, or star systems similar to the Milky Way. The collision, which took place some 200 million years ago, gave rise to radio waves which are just now reaching the earth. The nature of the majority of the 120 radio stars which were then known remained a mystery.

In 1953 a new radio telescope, intended to attack this problem, was completed at Cambridge. This telescope was much larger than any previous instrument, and it was designed to obtain the greatest possible accuracy in the positions of the radio stars. It consists of four separate units, each in the form of a cylindrical parabola, the two pairs being separated by about a third of a mile. The total "collecting area" of the telescope is about one acre.

During the last few months a survey of the sky with this powerful instrument has been completed, and a total of nearly 2,000 radio stars has been found. About 60 of them have been related to visible objects, and it has been possible to make some remarkable deductions about the nature of the remainder. It now seems probable that nearly all of them are extremely distant nebulæ, most of them being beyond the reach of the most powerful optical telescope. By penetrating further into space than any previous observations made by mankind, the new telescope

should enable deductions to be made about that most fundamental of astronomical problems, the origin of the universe.

Meteorology

The research activities of the Meteorology Section can be conveniently grouped under three main headings: spectroscopic investigations relating to the amount and radiative properties of the poly-atomic constituents of the atmosphere; the electrical properties and general physics of rain-clouds and rain; and the lightning discharge and disturbances of the natural atmospheric electric field due to lightning and also to other causes.

Under the first heading an investigation of the effect of pressure on the infra-red absorption band of ozone at 9·6μ, and an application of the results to study and interpretation of this band formed in the spectrum of the solar radiation by absorption in the atmosphere, have just been completed. An attempt is in progress to redetermine, more accurately than hitherto, the absolute values of the ozone absorption coefficients in the ultra-violet band near 3,000 Å; these coefficients are used in the determination of the amount of ozone in the atmosphere.

In the second category radar equipment is being used to study the vertical motions in rain-clouds of various types. In these observations the Doppler shift in the frequency of the echo from the raindrops is observed, the ultimate object being the determination of vertical air motions. Experiments are also in progress relating to the electrical properties of individual raindrops.

Finally, the waveform and frequency spectrum of atmospherics due to distant lightning discharges are being studied with particular reference to seasonal and temporal changes and to systematic differences in respect not only of distance but also of geographical position of the source. Disturbances of the electric field, due to all causes, in the frequency range from about 50 c/s to 1 cycle in several seconds are also being investigated systematically in an attempt to elucidate their causes.

Very-Low-Temperature Phenomena

The Royal Society Mond Laboratory specialises in research at very low temperatures, mostly below 4·2 deg K. Such temperatures are achieved by the use of liquid helium, which boils at this temperature under atmospheric pressure and at lower temperatures if the pressure is reduced.

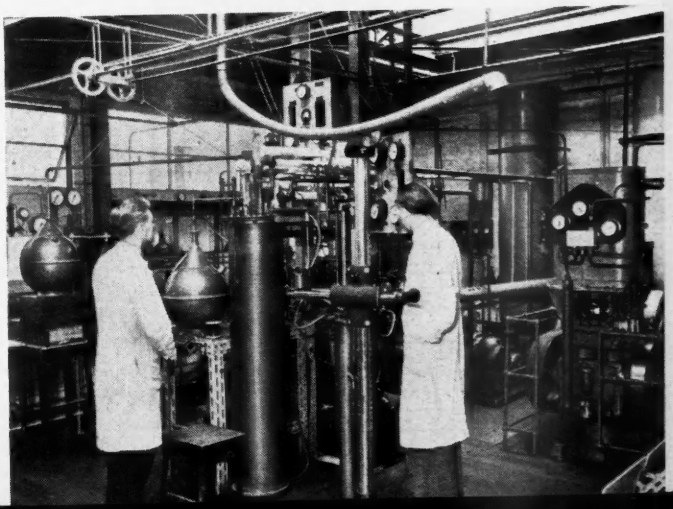
The chief lines of research in the Laboratory are on phenomena of a new character which make their appearance at these low temperatures. The principal phenomena are the behaviour of liquid helium itself, superconductivity and certain other properties of metals. Both superconductivity (total loss of electrical resistance of certain metals) and the peculiarities of liquid helium set in at characteristic temperatures, and the transition has similarities to the beginning of a condensation process. In the metal the behaviour is as if an increasing proportion of the electrons condense into a new and remarkably mobile state, while in liquid helium a proportion of the mass of the liquid seems to condense into a "superfluid" state. Many of the properties of both superconductors and liquid helium can be described qualitatively, and to some extent quantitatively, in terms of this "two-fluid" theory, the two fluids corresponding to the condensed and the "normal" states. Although this kind of picture proves helpful in the interpretation of many effects, it has not as yet a very firm theoretical basis, and much of the research is concerned with clarifying the picture and investigating its limitations.

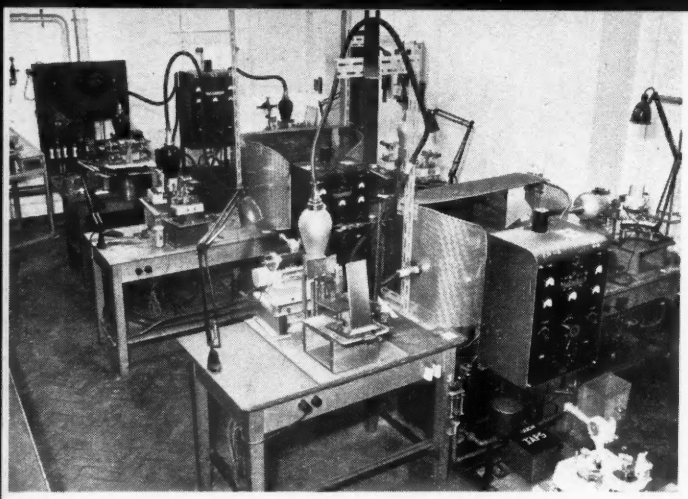
For instance, according to this picture it is to be expected that although a superconductor has zero resistance for d.c. it should show appreciable resistance for v.h.f. currents. The "normal" electrons can be thought of as providing a resistive path in parallel with the purely inductive path provided by the condensed "superconducting" electrons, and it works out that it is only at v.h.f. that an appreciably resistive impedance should appear. This is in fact found experimentally, and a detailed study is being made of how this high frequency resistance varies with temperature, frequency and other relevant parameters. Another problem in connection with superconductivity is a study of the surface energy at a boundary between superconducting and normal regions in the metal. This surface energy is important in determining the magnetic behaviour of a superconductor, and its variations with temperature and from one superconductor to another provide useful clues to the basic theory.

Research on non-superconducting metals is mostly concerned with attempts to determine their actual electronic structure, the number of "free" electrons and the distribution of their energies. The methods of attack are studies on single crystals of the "anomalous skin effect" and the "de Hass—van Alphen effect." The first effect appears at low temperatures when the mean free path of the electron becomes so long that it is greater than the conventionally calculated skin depth for high frequency

Transmitting and receiving units with recorders used in the study of "radio-stars"

The Royal Society Mond Laboratory specialises in research at very low temperatures, mostly below 4·2 deg K





The Crystallographic Section employs X-ray diffraction techniques to study the structure of solids

currents. In these circumstances Ohm's law no longer applies, since the electric field is varying considerably over a free path. A new theory has been worked out which involves the details of the electronic energy states, and information about these states can be obtained from the experimentally found variation of the effect in different crystal directions. The second effect is a peculiar oscillatory variation with magnetic field of the feeble magnetic susceptibility; these oscillations become pronounced in single crystals of many metals at low temperatures. Here again the details of the effect give direct information about the electronic states, so that experiments on this effect—particularly at very high fields (of order 10^5 gauss) are likely to contribute usefully to the electron theory of metals.

Crystallographic Section

In the Crystallographic Section of the Laboratory, X-ray diffraction techniques are applied to the study of the structures of solids. In some cases, it is the invention of a new trick in experiment, or in the interpretation of the observations, which provides the special interest of the research. In general, however, the problems are chosen either because a knowledge of the structural detail is expected to throw light on some important or unusual physical property, or with a view to the provision of information which may serve as a basis for theoretical developments.

Three groups of problems may be cited in which the examination of the atomic architecture is the prime interest. The first involves the structure-analysis, with the highest accuracy attainable, of a number of felspars. The felspar minerals form a very important part of the earth's crust, and their structures have been known with moderate accuracy for many years. This work has been undertaken because only when detailed knowledge of their structures is available can mineralogical and geological observations be fully interpreted. Another fascinating mineral problem is that of the hydrated calcium silicates. The results so far obtained are proving of considerable interest in relation to the behaviour of the raw materials used in the cement and concrete industries. In this case the materials are rarely found in well-developed form in nature, their synthesis in the laboratory is a matter of considerable difficulty, and the poor crystalline development itself poses a variety of problems. After a long hold-up due to these difficulties, results are now beginning to emerge, almost simultaneously, in a number of laboratories all over the world.

A second group of workers, concerned specially with the high-accuracy analysis of organic structures, have recently been concentrating on locating the electron density associated with hydrogen atoms in such structures. The aim here is to obtain an understanding of the role of the hydrogen atom in contributing to the stability of the molecule and in holding the molecules together to form the crystal. In the course of the development of this group of researches a good deal of progress has been made with the use of so-called "direct" methods of structure-analysis, which have been the subject of so much discussion especially in the United States.

One of the problems of great interest at the present time in connection with the crystal chemistry of metals is the role of atoms of the transition metals. Accurate structure analysis of a variety of aluminium-rich alloys of the transition metals Co, Mn, Fe and Cr has resulted in the provision of some of the factual information which has hitherto been lacking, and has begun to fill one of the conspicuous gaps in the knowledge of the structural geometry of the metals.

In the examination of the textures of solids a rapidly growing body of researches has sprung from the use of X-ray microbeams to study the diffraction patterns obtained from very limited regions of a bulk specimen of a metal. It is now possible to speak with certainty of the sizes and states of strain of the "fragments" resulting from the breakdown of the crystal grain when polycrystalline metals are subjected to mechanical and thermal treatments of various kinds. Moreover, a beginning has been made in correlating the X-ray measurements with optical and electron microscope observations on such materials. The resulting picture of the nature of a polycrystalline metal is capable of interpretation in terms of dislocation theory, which is fundamental to the mathematical treatment of slip, hardening, fatigue, creep and other technically important aspects of metal behaviour.

For many years an enormous amount of effort has been devoted to physical and chemical measurements on coal but previously there has been no really satisfactory understanding of the physical nature of the coal substance. As a result of a research begun in the Laboratory a few years ago, it is now possible to demonstrate the nature of the atomic arrangement in a coal molecule, and of the stacking of coal molecules in the massive sample. The structure not only explains the X-ray observations but is also in harmony with the chemical, optical and petrological data, hitherto very largely uncorrelated, for coals of various ranks and for their carbonisation products.

Finally, measurements of the diffuse scattering of X-rays from metals and other crystals of simple atomic structure have led to valuable new data about the elastic properties of these crystals and about the thermal motions of the constituent atoms. This branch of crystal physics, long regarded as of somewhat academic interest, is now of much importance in relation to some very recent developments in the theory of crystal elasticity, and in connection with the study of the peculiar properties of "imperfect" crystals.

Electron and X-ray Microscopy

The work of the Electron Microscope Section falls into two parts: electron microscopy and X-ray microscopy. The Section also provides a service in electron microscopy for other departments of the University and at present four electron microscopes of differing capabilities are in use. In the field of electron microscopy the research is concerned with preparative techniques and their applications, primarily in the biological field.

It is impossible to make lenses for focusing X-rays, except of very long focal length, and so a microscope of

normal design cannot be made. However, the advantages of using X-rays (greater penetration and higher resolving power than with light, due to the much shorter wavelength) have led to a search for alternative methods of microscopy. Workers at the Cavendish have been developing one of the three techniques which seem to promise success, the other two being under investigation in Stockholm and in Stanford University, U.S.A., respectively.

At the Cavendish Laboratory the projection method is being studied, in which a pinpoint source of X-rays casts an image of a nearby object on to a screen or photographic plate at a distance; the magnification is given simply by the ratio of the respective distances of image and object from the source. The resolving power depends primarily on the size of the source and this can be made extremely small by using electron optical methods to focus the electron beam inside the X-ray tube into a fine focal spot on the target. In fact the apparatus is very much like an electron microscope upside down, two successive magnetic lenses forming at the target a highly demagnified image of the electron source. Focal spots smaller than 0·25 micron in size can now be obtained. By making the target in the form of a thin metal foil, sealing the end of the X-ray tube, the X-ray source is in effect in the window of the tube. The object for examination can be brought very close to the source and a high geometrical magnification obtained in the X-ray image in a short camera length (1in-2in) and at a reasonably short exposure time (1 min).

The X-ray microscope has obvious applications for investigating the internal structure of biological specimens, but it can also be used in metallurgy where a system of any two (or more) phases is open to investigation in depth. Stereophotographs are readily obtained, showing the internal structure of (for instance) an aluminium-copper alloy in detail in three dimensions.

This Siemens electron microscope is the most powerful at the Cavendish and it incorporates an optical microscope to achieve further magnification of the specimen under examination

The determination of the amounts of elements in a mixture or a biological specimen by differential absorption of X-rays, or by fluorescence analysis, has been long known. The small source obtained in the X-ray microscope offers special advantages for investigating the point-by-point distribution of an element in a specimen. With the aid of a special D.S.I.R. grant, investigations are being made into the possibility of doing so by a semi-automatic method, employing proportional counters as recording means. The point-focus tube can also be adapted to micro-diffraction. Owing to the high specific loading (above 100 kW/mm^2) exposure times, when very small crystals are to be examined, are much less than with a tube of conventional design. A " flying-spot " system has been developed from the point-focus X-ray tube, the energising electron beam being scanned across the surface of the specimen. The composition of the specimen can be determined by analysis of the X-rays emitted from it, either by a spectrometer or proportional counters; or an image of the surface may be displayed on the screen of a synchronously operated cathode ray tube.

There is also in the Laboratory a research unit supported by the Medical Research Council, under the direction of a University officer. The work here is devoted to the study by the methods of X-ray analysis of the structure of large molecules of biological importance and is primarily concerned with the hæmoglobins of blood and muscle.

Some members of the teaching staff of the Cavendish and some research students are specialists in theoretical physics, though much of the responsibility of teaching and research in this subject is with the Faculty of Mathematics. It is the policy of the Cavendish to encourage research in theoretical physics in the closest contact with experiment and to provide, where space allows, office accommodation for the theorists in close proximity to the experimental work. The ideal physicist would perhaps be a master of theory and of experiment, but as men rarely have both talents in equal measure the aim is to ensure that they work together and understand each other's point of view. In most of the sections, theorists work in this way, especially in nuclear physics, in radio, in fluid mechanics and in the branches of the physics of the solid state which relate to crystallography and the work of the Mond Laboratory.

We should like to express our appreciation of the assistance given by members of the staff of the Cavendish Laboratory in the preparation of this article.

Mass Spectrometer Researches

SPECIAL features of an experimental sector-field mass spectrometer that was constructed at the National Physical Laboratory and some of the experimental researches undertaken with this instrument are described by Dr. G. P. Barnard in " Mass Spectrometer Researches," published by H.M. Stationery Office (price 3s 6d) for the Department of Scientific and Industrial Research. Various ion source designs of the electron bombardment type were examined with the aim of gaining a better understanding of the role of the magnetic field in the source region.

The researches described include work on the integrated effect of the fringing flux in sector-field instruments; on ion sensitivity and gas concentration with pseudo-molecular-beam arrangements; and on studies of voltage coefficients, peak shapes and ion transmission efficiencies for various source arrangements. The relationship between source magnetic field strength and mass resolution is also examined.

Circulating Currents in Transmission Systems

By A. SALZMANN, Dipl.Ing., A.M.I.E.E.

An Analysis of the Problems Involved

GENERALLY speaking circulating currents arise in power transmission systems as a result of switching operations, voltage injection into the system, or parallel operation of transformer feeders and cascade connection of transformers in loop circuits. Thus three types of circulating current arise from transmission of power.

The first type of circulating current causes uncontrolled redistribution of power flow. It increases the copper losses of some sections of the transmission system and may overload cables and overhead lines. The contribution of this current to the efficiency of system operation is nil. We will call this current " uncontrolled circulating current."

The second type of circulating current is caused by voltage injection into the system. The control of this voltage, and consequently the current, facilitates alteration of the power distribution at will. Under-loaded conductors and transmission elements can be forced to carry currents to full capacity, while the current in overloaded transmission lines can be limited on account of the conductor rating. It follows that this type of circulating current is not objectionable and is necessary for improvement of the efficiency of system operation. We will call this current " desirable circulating current."

The third type of circulating current is produced by:—(*a*) two or more transformers or transformer feeders operating in parallel and having dissimilar no-load voltage ratios, or (*b*) transformers with dissimilar phase angles and no-load voltage ratios connected in cascade in loop circuits.

This current circulates between the units without interfering with the load and is present even at no-load. It may have adverse effects on the operation such as increased copper losses which results in decrease of output of one unit in order to avoid overloading. Naturally this current is unwanted and therefore objectionable. Let us denote this current " undesirable circulating current." In general a small undesirable circulating current is tolerable and only if the magnitude becomes appreciable does it have an adverse effect on system operation.

Let us consider a simple circuit as illustrated in Fig. 1. It is assumed that circuit-breaker S_1 is closed and breakers S_2 and S_3 open, current in sections (a) and (e) is smaller than in (b) and (d), hence the potential V_a is higher than V_b, and a voltage $e = V_a - V_b$ will appear across the open switch S_3. This voltage varies in phase and magnitude and its value depends on the currents flowing in various branches of the network. According to Kirchhoff's law the magnitude of this voltage is equal to:—

$$e = I_e Z_e + I_d Z_d - I_a Z_a - I_b Z_b \ldots . (1)$$

where Z_a; Z_b; Z_e; Z_d are line impedances. Thus dissimilar section impedances and variable loads will result in a phase displacement and voltage difference between the two circuits shown in Fig. 1. Even if the in-phase component of the voltage e would be zero, a voltage may exist across the open switch due to the phase displacement between V_a and V_b causing a circulating current.

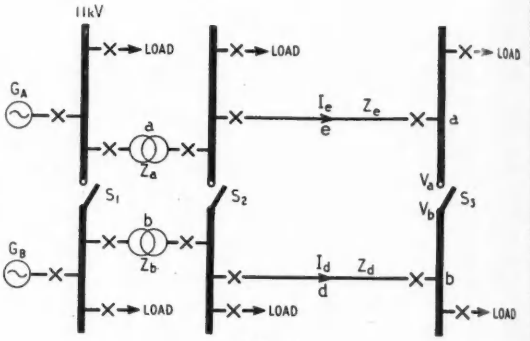


Fig. 1

By closing breaker S_3 the voltage e is short-circuited and a circulating current

$$I_C = e/(Z_a + Z_b + Z_d + Ze) \ldots . (2)$$

superimposed on the normal line currents will flow throughout the network and modify the current distribution. This results in V_a becoming equal to V_b. For lagging power factor the circulating current I_C is to be added vectorially to the line currents in the sections (a) and (e) and subtracted from the line currents in (b) and (d).

In general, modification of currents in various branches due to switching operations in large networks (in case of emergency or for maintenance purposes) is caused by uncontrolled circulating current. Some conductors and transmission elements may become overloaded, the voltage drop along these sections is unduly increased and in addition trip-out of normal feeders may take place. Obviously, circulating currents caused by switching operation may have adverse effects on system operation.

The second type of circulating current is produced by injecting at any point in the system a voltage varying in phase and magnitude. In this manner the circulating current, consequently the current distribution in various branches of the system, can be modified at will.

If the circulating current is large it is economical to install a combined in-phase and phase angle control unit. For instance, if the voltage applied across the open switch equalises the voltage difference between (a) and (b) and shifts the phase position of, say, voltage V_b in order to compensate for phase angle difference, the circulating current becomes zero and no alteration in current distribution will take place.

According to equation (1) the injected voltage must be equal in phase and magnitude to the vector sum of the impedance drop in both feeders. When it is required to modify the current distribution from, say, I_e/ϕ_e to $I_e{}^1/\phi_e{}^1$ and I_d/ϕ_d to $I_d{}^1/\phi_d{}^1$ the injected voltage is found by Kirchhoff's law

$$e^1 = I_a/\phi_a \times Z_a/\theta_a + I_b/\phi_b \times Z_b/\theta_b + I_e{}^1/\phi_e{}^1 \times Z_e/\theta_e + I_d{}^1/\phi_d{}^1 \times Z_d/\theta_d \ldots . (3)$$

and the circulating current is equal to

$$I_C = e^1/(Z_a/\theta_a + Z_b/\theta_b + Z_d/\theta_d + Z_e/\theta_e) \ldots . (4)$$

As a general rule if the natural division of active and reactive power is not desirable, such as load division between transformer feeder and cable, or if the current in a loop circuit is to be limited on account of the rating of the conductor or transmission elements any modification of the current distribution can be obtained by producing a voltage varying in phase and magnitude.

It follows that a circulating current caused by injected voltage controlled either manually or automatically is desirable on the ground of improvement of system operation.

Example 1. *Circulating current produced by phase displacement between system voltages.*[1]—This current can be used (see Fig. 2) for melting ice from transmission lines. It is, of course, a desirable circulating current, produced by introducing an angular phase displacement between the voltages at the supply points (A) and (B) as illustrated in Fig. 2a. The circulating current plus the load current is made large to melt the ice or to prevent its formation.

Under normal system conditions the product of transformer ratios around the closed loop circuit is unity and the sum of angular phase shift around the closed loop is zero, hence no circulating current is present. For unit T_1 (Fig. 2a) the angular phase shift between primary and secondary voltages is + 30 deg and for unit T_2 the phase shift is − 30 deg, hence the total angular phase displacement between the vectors on the supply sides (A) and (B) taking the primary of T_1 as reference is (+ 30 deg − 30 deg) = 0 deg.

However, if unit T_2 is switched for + 30 deg displacement by reversing the polarity of the star connected winding as shown in Fig. 2b and suggested by Oehlwein,[1] a total angular phase displacement of (+ 30 deg + 30 deg) = 60 deg can be established during the period of ice combating.

This can be readily seen from the combined vector diagram Fig. 2c in which the phase angle between the vectors on the supply side (A) and (B) is 60 deg. Driving voltages E_d are established in each phase which are equal to the phase voltages, consequently a circulating current $I_C = E_d/Z_T$ (Z_T = total loop impedance) will flow throughout the circuit. The magnitude of the circulating current may prove sufficient to melt the ice from the transmission lines in a very short time, under normal system conditions, without interfering with the load.

Example 2. *Circulating current produced by injected voltage.* — Let us consider a loop circuit consisting of several generating stations interconnected through short tie lines (see Fig. 3a). It is required to produce a circulating current throughout the system in order to dispatch power via selected routes, say a certain amount of power from generating stations A and B to station C. Station A can export only a limited amount of power to C via tie line L_3 because of the thermal rating of the conductors, hence the bulk of supply is to be transferred from A via route A — L_1 — L_2. The export of power from generating station B is limited and takes place via interconnector L_2.

Generally kilowatt transfer from station A is achieved by increasing the steam supply to the turbines. The active power flow is from A to B if the voltage vector V_A advances on voltage V_B by an angle $(\alpha_1 - \alpha_2)$ and on V_C by an angle α_1, as shown in the vector diagram (Fig. 3b). The reactive power is controlled by the generator excitation and the flow is from A to B if $V_A > V_B$. However, since the individual generating stations have to feed their own supply areas, the busbar voltages $V_A = V_B = V_C$ have to be maintained approximately constant and the reactive power flow is controlled by changing of the transformer ratios of the units T_1; T_3; T_6.

Consider first the power flow from A to C via station B. It is obvious that unit T_3 needs adjusting so that voltage V_{B_1} as illustrated in Fig. 3b will secure voltage V_C at the receiving end. Similarly, tap change unit T_1 has to be adjusted to V_{A_1} to maintain V_{B_1} at B_1.

To transmit power over the line L_3, the ratio or tap change regulator T_6 has to increase the sending end voltage to V_{A_2} to maintain a receiving end voltage V_C^1 equal to the station voltage V_C. Note that V_C and V_C^1 are displaced in phase by an angle β. In general, these voltages can be brought closer in phase by increasing V_{A_2} but this will prove impracticable because of the limiting tap change range of the on-load ratio regulator T_6.

A vectorial difference $V_C - V_C = e$ exists causing a circulating current of the magnitude $I_C = e/(Z_1 + Z_2 + Z_3)$ to flow round the loop circuit. This current alters the magnitude of the line currents I_1; I_2; I_3 and affects the desired power flow round selected routes.

It follows, in order to dispatch a certain amount of power via selected tie lines, we must bring the voltages V_C and V_C^1 into phase to eliminate the circulating current I_C. This is achieved by injecting at any point of the loop circuit a voltage

$$e = V_C - V_C^1 = I_1/\phi_1 \times Z_1/\theta_1 + I_2/\phi_2 \times Z_2/\theta_2 + I_3/\phi_3 \times Z_3/\theta_3$$

Fig. 2

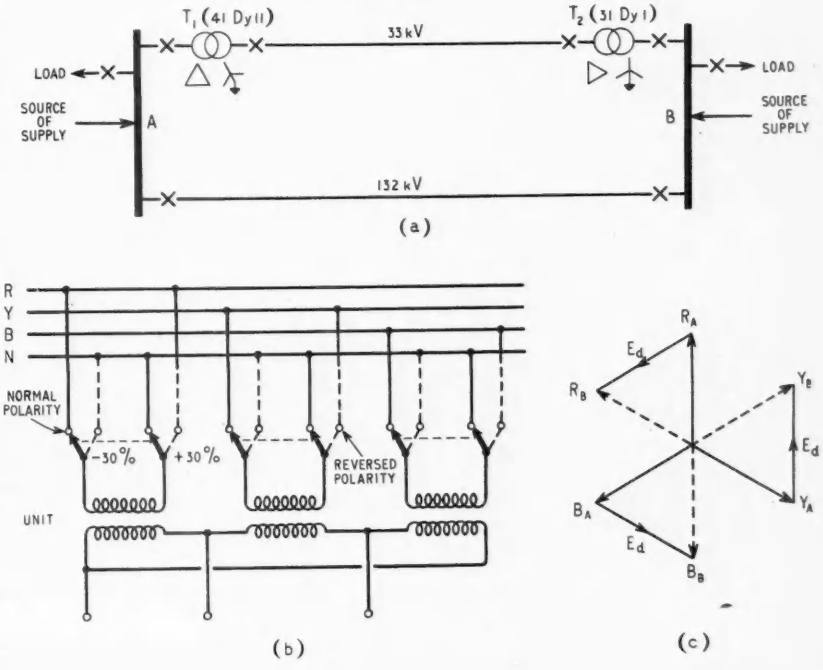
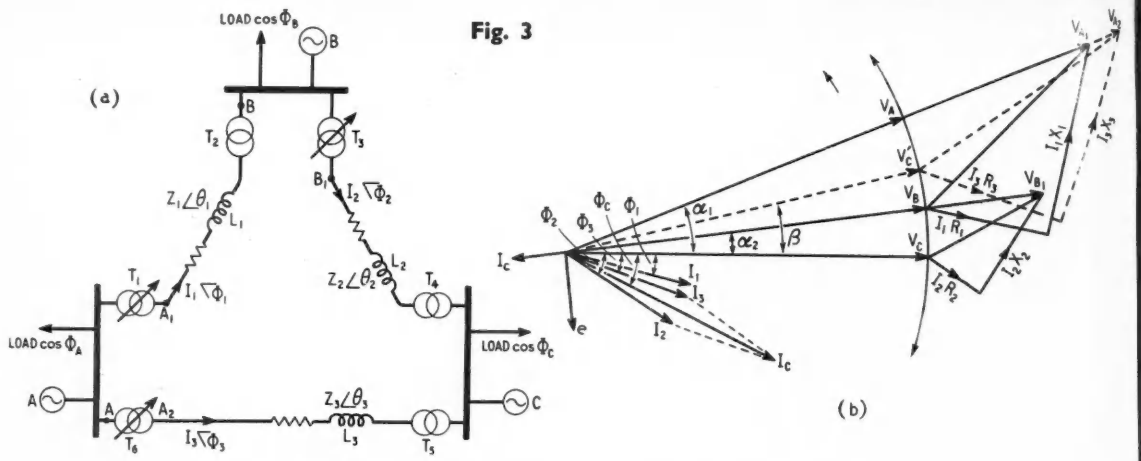


Fig. 3



This example shows that if the busbar voltages of generating stations forming a closed loop circuit are to be kept constant and if power is to be dispatched via selected routes, the most flexible control of power flow is obtained by the use of tap changer units such as T_1; T_3; T_6 in each tie line and in addition to employ a combined in-phase and phase angle unit, preferably in the tie line having the smallest conductors.

Let us consider Fig. 1 again and assume that breakers S_1; S_2; S_3 are closed. It is obvious the load should be shared among transformers T_A and T_B in proportion to their ratings kVA_A and kVA_B. This is accomplished if the transformers belong to the same vector group, have the same percentage impedance, same ratio of resistance to reactance and identical no-load voltage ratios.

In the example the transformers have different voltage ratios such as on-load tap changer units operating several steps apart; a circulating current is set up and circulates between T_A and T_B even at no load. This current is equal to

$$I_C = (E_A - E_B)/(Z_A + Z_B) \ldots . (5),$$

that is the difference in secondary no-load voltages divided by the sum of the impedances Z_A and Z_B expressed in ohms where Z_A is the impedance of unit T_A and Z_B the impedance of unit T_B.

Expressed in per unit we obtain

$$I_C = e\%/(Z_A\% + Z_B{}^1\%) \text{ p.u. where } Z_B{}^1 = Z_B \frac{kVA_A}{kVA_B} \frac{(E_B)^2}{(E_A)^2}$$

the impedance expressed in per cent on a common kVA base, and voltage base $E_A = 100\%$ and $e\%$ the difference in no-load secondary voltages due to on-load tap changer units operating some steps apart.

Example 3.—Suppose two units have equal ratings, identical ratios of resistance and reactance, equal impedances $Z_A = Z_B = 8\%$ and they operate four steps apart with 1·25% steps. The difference in no-load secondary voltages is $e = 4 \times 1{\cdot}25 = 5\%$ and the impedance of unit (B) is equal to $Z_B{}^1 = 8 \times 1 \times \left(\frac{95}{100}\right)^2 = 7{\cdot}2\%$. The circulating current will be equal to $I_C = 5\%/(8\% + 7{\cdot}2\%) = 0{\cdot}33$ p.u. or 33% of the full load current of unit T_A on the higher voltage tap.

Current I_C lags behind the load current I_A in the unit T_A and leads the load current I_B in unit T_B as illustrated in the vector diagram Fig. 4a. It reaches its maximum value under abnormal automatic operation if the per cent voltage difference (e) is equal to the per cent tap range of the transformer.

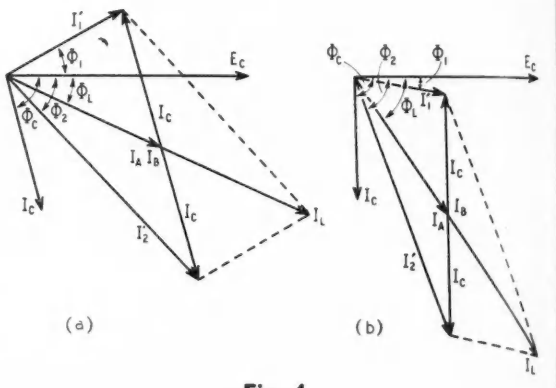


Fig. 4

In general an increase in load of the transformer T_A due to the circulating current and the decrease of load in unit T_B depends on the per cent voltage difference (e), the power factor of the load, and p.f. of the circulating current. A low load p.f. and low circulating current p.f. as shown in Fig. 4b will result in a large amount of load increase in unit T_A.

It can be proved that the load increase in one unit is larger, as illustrated in the vector diagram, if the impedances are identical, but the ratio of per cent resistance and reactance is dissimilar.

The circulating current due to dissimilar no-load voltage ratios of transformers is undesirable as it increases the copper losses and reduces the permissible output of one unit and may cause a complete shut down of a transformer station.

Example 4.—Consider the previous example and assume ±10% transformer tap range and both tap changers travel to the maximum opposite position due to, say, a faulty interlocking device. Each unit carries 85% of the full load current at $\cos\theta = 0{\cdot}866$ lagging. For this case the circulating current is equal to $I_C = 20\%/(8\% + 7{\cdot}2\%) = 1{\cdot}32$ p.u. or 132% of the full load current. Unit T_B at the lower tap position will carry, according to the vector diagram 4a, for $\phi_C = 90$ deg and $\phi_L = 30$ deg the current

$$I_1{}^1 = -(-j\,132) + 85\cos 30^\circ - j\,85\sin 30^\circ = 116\%$$

of the full load current and unit T_A, at the higher tap position

$$I_2{}^1 = 85\cos 30^\circ - j(132 + 85\sin 30^\circ) = 190\%.$$

Obviously the circulating current will cause the protective gear to remove unit T_A from the circuit and unit T_B carrying 170 per cent of the full load will follow after a short period, thus causing a complete shut down of the transformer station.

It follows that an excessive circulating current may have an adverse effect on parallel operation of power transformers. The current may cause overheating or burning out of one unit although the load demand does not exceed the kVA rating of the transformer.

If more than two transformers or transformer feeders are involved, having dissimilar no-load voltage ratios and impedances, the circulating current is larger than for two units and can be derived in a similar manner. However, it is advisable to apply the parallel-generator theorem because this method is less laborious.[2]

According to this theorem the common voltage of a number of secondary windings of transformers to be paralleled say T_1; T_2; T_3, and illustrated in Fig. 5, is equal to $V = I_S Z$ where I_S is the sum of short circuit currents $I_{S_1} + I_{S_2} + I_{S_3} = I_S = E_1/Z_1 + E_2/Z_2 + E_3/Z_3$ of the individual units and Z the parallel combination of circuit impedances including the load impedance Z_L ($1/Z = 1/Z_1 + 1/Z_2 + 1/Z_3 + 1/Z_L$). The load current in the individual secondary circuits is $I_1 = (E_1 - V)/Z_1$; $I_2 = (E_2 - V)/Z_2$; $I_3 = (E_3 - V)/Z_3$.

As a check: $I_1 + I_2 + I_3$ must be equal to $I_L = V/Z_L$. Comparing the currents

$$I_1^1 = I_L \frac{Z_2 Z_3}{Z_1 Z_2 + Z_2 Z_3 + Z_3 Z_1} = I_L \frac{Z_2 Z_3}{Z_T};$$

$$I_2^1 = I_L \frac{Z_1 Z_3}{Z_T}; \quad I_3^1 = I_L \frac{Z_1 Z_2}{Z_T};$$

due to identical no-load voltage ratios with I_1; I_2; I_3 the currents due to dissimilar no-load voltage ratios, we obtain the circulating current in each circuit:

$$I_{C_1} = I_1 - I_1^1; \quad I_{C_2} = I_2 - I_2^1; \quad I_{C_3} = I_3 - I_3^1$$

For any number of transformers the approximate value of the circulating current can also be obtained by multiplying equation 5 by $(2 - \frac{2}{n})$ where n is the number of units operating in parallel.[3] Thus we get

$$I_C = \frac{e\%}{Z_A\% + Z_B\%} (2 - \frac{2}{n}) \ldots . (6)$$

It should be pointed out, however, that circulating current set up in on-load tap changer units is not always undesirable. This current may prove useful for testing

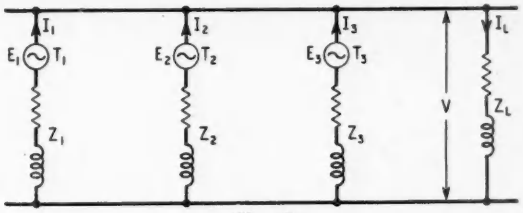


Fig. 5

relays and meters, etc., because it can be regulated over a wide range by adjusting the taps. This current is mainly wattless, that is roughly in quadrature with the voltage producing it.

Example 5.—Two units operating in parallel are several taps apart which results in an undesirable circulating current. For clarity we have selected single-phase transformers as shown in Fig. 6. In this example we want to demonstrate how the undesirable circulating current can be eliminated automatically.

Let us consider first that unit No. 2 is withdrawn from the circuit and transformer No. 1 is operating with an automatically controlled tap changer.

In general, the voltage V_L at the load centre can be maintained constant if pilot wires are provided from this point back to the substation. If V_L falls or rises below or above a value for which voltage regulating relay R_1 is set, the voltage across this relay will fall or rise as well, causing the tap changer gear to adjust the voltage at the substation busbars to maintain the load centre voltage approximately constant.

Economically this arrangement is not justified and the difficulty can be overcome by employment of a line drop compensator (l.d.c.) as shown in Fig. 6, representing the feeder impedance $Z_L = R_L (n/N) + j X_L (n/N)$, the latter being referred to the secondary circuit. In this formula R_L = feeder resistance, X_L = feeder reactance, n = c.t. ratio and N = p.t. ratio. Thus the voltage drop ΔE_{C_1} across the l.d.c. is proportional to the drop along the feeder and is to be subtracted from the voltage at the potential transformer. Across the voltage control relay R_1 a voltage E_{R_1} will be present which varies with the load. In this manner we are able to maintain the load centre voltage V_L approximately constant.

If the load increases, the current in the l.d.c. circuit increases also. Hence ΔE_{C_1} becomes larger and the voltage across the control relay R_1 becomes smaller. Relay R_1 controlling the raise contracts (r_1) will initiate the tap

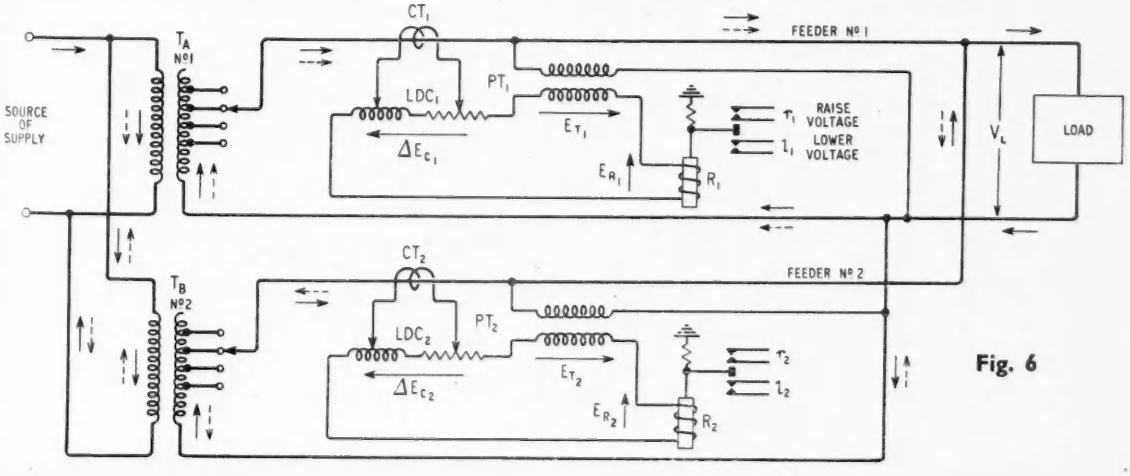


Fig. 6

changer via tap change motor to insert more turns in the secondary circuit thus raising the voltage level and maintaining the voltage at the load centre constant.

It should be noted that the tap change operation takes place on the primary of the transformer which is the usual practice because of the smaller primary current. Here primary windings have to be removed in accordance with $E_S = E_P (n_S/n_P) = K/n_P$ if the voltage has to be raised and primary turns increased if the voltage has to be lowered.

In actual fact the circuit shown in Fig. 6 is more complicated, but for clarity we have omitted various circuit elements such as time delay relays which avoid regulation on momentary voltage fluctuations. These omissions will not change the fundamental principle of operation.

Now, if both units are working in parallel and assuming they are several steps apart the circulating current resulting from this difference in transformer ratios will flow as indicated by dotted arrows if transformer T_1 is at higher tap position than T_2. The solid arrows indicate the direction of the load current. It is obvious that, since unit No. 1 carries more current, its l.d.c. causes the voltage relay via closed raise contacts (r_1) to initiate the drive of the tap change device to a higher rated voltage tap, which results in a further increase of the circulating current until the tap changer has reached the maximum raise position. Similarly the tap changer of transformer No. 2 (the latter carrying less current than unit No. 1) is initiated via line drop compensator, via voltage regulating relay and closed lower contacts (l_2) to move to the maximum lower position, which results in excessive circulating current because unit No. 1 moves towards maximum raise position and No. 2 towards maximum lower position. Thus it follows that when two transformers are on different tap positions the effect of the circulating current on the line drop compensator is to drive the units apart, causing overheating of one unit.

Obviously steps have to be taken to bring both units closer together by eliminating the circulating current. Generally, there are two schemes for controlling the circulating current. One is the in-step method whereby one unit selected as master-unit after moving one step opens its control circuit and remains open until the second or follower-unit catches up with the master unit.

The second method is based on current control and there are several different schemes which have in common interconnection of the l.d.c. circuits, with the object of driving the units closer together, thereby reducing the circulating current to the minimum value.

If the transformers are a considerable distance from each other it will be impracticable to interconnect the l.d.c. circuits. Here, the reverse reactance compensation scheme should be applied to reduce the circulating current to the minimum. This scheme requires reversing the connections of the reactance element of the l.d.c. which causes the voltage regulating relay to drive the transformers closer together.[4]

We will now consider only one current control scheme, namely the "cross current compensation." Here the current transformer CT_1 (Fig. 6) is connected to LDC_2 and the current transformer CT_2 to the line drop compensator LDC_1. Since unit No. 1 carries more current its effect on LDC_2 will cause the voltage E_{R2} to become smaller and consequently will cause tap changer No. 2 to move to a higher rated voltage tap and will bring both units closer together. Similarly since unit No. 2 carries less current its effect on LDC_1 will cause voltage E_{R1} to become larger. Voltage relay R_1 controlling the "lower contacts" (l_1) will cause the tap changer to move towards a lower rated voltage tap, thus tending to bring also both units closer together.

Undesirable circulating current may result also from operation of units such as step-up and step-down transformers within a power system as shown in Fig. 7. These units should be matched as regards ratio and phase angle

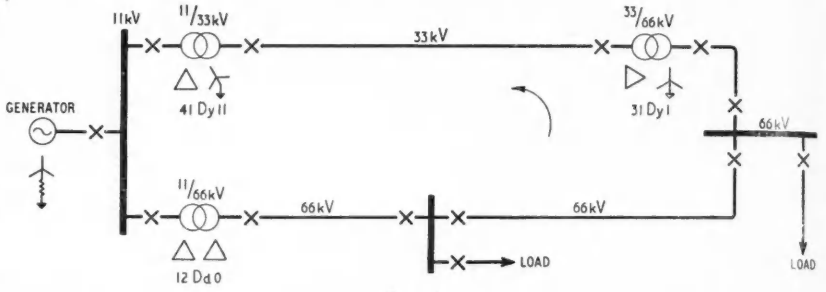


Fig. 7

to eliminate the circulating current. This is achieved if the product of all the transformation ratios around the loop is equal to unity and the sum of phase shifts of individual transformers around the loop and looking in one direction is zero. Taking the 33 kV line as reference and going in the direction indicated by the arrow, the product of transformer ratios is $33/11 \times 11/66 \times 66/33 = 1{\cdot}0$ and the sum of phase angle is $+30$ deg $+0$ deg -30 deg $= 0$. However, if the product of transformation ratios is not unity or the sum of the phase angles is not zero a circulating current will be present and if uncontrolled may have adverse effects on the power flow throughout the loop circuit.

The conclusion to be drawn from the foregoing examples is that a large and uncontrolled circulating current has adverse effects on system operation. On the other hand, a circulating current produced by in-phase and phase angle unit is desirable because we can control the power flow at will which results in an improvement in the efficiency of the system. In the case of under-loaded conductors and transmission elements they are forced to "do better" to carry current to the full capacity, while the capacity of overloaded elements may be limited on account of the thermal rating.

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[2] Molloy–Say–Walker: "Electrical Engineer's Reference Book." Seventh Edition. Parallel-Generator Theorem, p. 1–85.
[3] W. C. Sealey: "Circulating Currents in Parallel Load Ratio Control Transformers." *Allis-Chalmers Electrical Review*, 2nd Quarter, 1953.
[4] W. C. Sealey: "A Simple Method of Paralleling Load Tap-changing Transformers." *Allis-Chalmers Electrical Review*, 3rd Quarter, 1954.

Instruments and Measurements Conference

THE fourth International Instruments and Measurements Conference will be held at the Institute of Technology, Stockholm, from 17th to 19th September. This is being organised by the Academy of Engineering Science and the Society of Technical Physicists. The general secretary is Mr. S. Malmstrom. An exhibition of measuring instruments will be held at the same time.

VIEWS on the NEWS

By REFLECTOR

WE all know owners of recalcitrant radio sets who, in order to secure continuity of programme, give those sets a smart tap or bang from time to time. Other electrical and mechanical contrivances are also kept going by this means, although as a regular practice it is to be deprecated. Occasionally, such treatment may be to the advantage of the public as was the case last week. Traffic signals at the busy Leadenhall Street-Gracechurch Street junction in the City of London failed to change colour for some time, causing long streams of traffic to be held up. Either spurred on by anger or because he thought it might be effective a conductor left his bus and bestowed a sharp kick on the signal column whereupon the signals resumed operation and the vehicles flowed on.

* * *

On the face of it the suggestion made by a correspondent to the *Financial Times* seems to be a good one. It is that household equipment should be written off and allowed for in respect of income tax in the same way as industrial equipment is. He says:—

"Most housewives get nowadays electric or gas cookers, and a 20 to 40-gallon hot water circulator—sink heater—electric, gas or oil radiators—electric sweepers, kettles and food mixers, and the larger houses would have central heating coke or coal fuel or perhaps oil burner installation. If all these are installed the cost would easily come to over £1,000, and a 10 per cent depreciation allowance would be welcome, and when the squeeze is past it would be an inducement for making homes up to date."

However just this might be I cannot imagine the Chancellor of the Exchequer giving it a second thought.

* * *

In the 18th May issue I commented upon a suggestion by the Mitcham branch of the E.T.U. that the Mayor's chain and the official mace should be melted down and used for a more useful purpose. I wondered what more useful purpose the branch had in mind. A correspondent suggests that I should read a certain paragraph in a report of the E.T.U. Conference on page 837 of the same issue. This mentions "the Mayor's welcome and the presentation of the Union's gold badges for long and meritorious service." So that's it!

* * *

I am not surprised that Mr. Woodrow Wyatt's television programme to which I referred a couple of weeks ago was resented by some delegates at last week's conference of the United Society of Boilermakers, Shipbuilders and Structural Workers. Mr. Wyatt's endeavour to persuade trade unionists to take an active part in the running of their unions was described as "the unwarranted interference by the B.B.C. in the affairs of the trade union movement." The resentment was by no means general for two delegates approved this attempt to shake members out of their apathy and in fact a resolution objecting to the broadcast was carried by only one vote.

The secretary of the Norwich branch of the Electrical Trades Union has sent a letter to the *Eastern Daily Press* saying that his branch is "gravely concerned" at the B.B.C.'s attempt to interfere in the internal affairs of the A.E.U. and adding rather strangely:—

"We strongly condemn any action calculated to remove or nullify the democratic rights of the individual members."

Of course Mr. Wyatt was actually trying to get individual members to exercise their democratic rights.

* * *

The *Nottingham Guardian-Journal* reports that at a recent local school prize distribution, Father J. F. McLean, secretary of the Nottingham Roman Catholic Diocesan Commission for Schools, said that girl guides would know how to cook over an open fire, and in view of the high cost of living that would give them an advantage over girls taught with gas, electric and solid fuel cookers in modern schools. The report is published under the heading "Girl Guides Make the Best Wives." There may be some men who enjoy food cooked by this primitive method (ex-boy scouts, perhaps?), but if matrimonial bliss depends on the wife's skill in the culinary art, then my money is on the girls who have been taught to cook with modern equipment.

* * *

Experiments by Thomas Alva Edison in the production of light from vacuum tubes were reported by the *Electrical Review* sixty years ago. In the issue of 12th June, 1896, headlines from the *New York World* were quoted:—

"Sunshine at Will—the Luminous Ether Harnessed by the Wizard Edison. Blazing Vacuum Tubes. . . . Invisible X-rays are Transformed into Beautiful Sunlight at his Touch. . . . American Genius Again Triumphant."

The *Review* was a trifle sceptical, suggesting that Edison's experiments were just larger-scale improvements on earlier work by Ebert and Tesla. It was thought that Edison coated the interior of a Röntgen tube with a phosphorescent substance, believed to be calcium tungstate. This coating broke down very rapidly which led the *Review* to the opinion that this was fatal to the commercial development of the idea. In the same article mention was made of vacuum tube lighting by another American, D. McFarlan Moore, who employed seven-foot lengths of 1in tubing:—

"The rarefied air in these tubes he brought up to a point of luminescence by means of a little 'vibrator,' consisting simply of a spring in a tiny glass tube, the play of which was governed by a small electro-magnet outside the tube."

The objection to this system was said to be "the tendency of the rarefaction of vacuum tubes to increase when powerful charges are sent through them."

PERSONAL AND SOCIAL

News of Men and Women of the Industry

THE Minister of Fuel and Power has reappointed for a further term **Sir Henry Self,** deputy chairman (administration), and **Lt.-Col. E. H. E. Woodward,** whose present membership of the Central Electricity Authority expires in August. The Minister has also appointed as part-time members of the C.E.A. **Mr. G. A. S. Nairn** and **Sir Leslie Nicholls.**

Mr. Nairn has been a member of the Merseyside and North Wales Electricity Board since 1949 and he was formerly chairman of Lever Bros. (Port Sunlight), Ltd. He is also chairman of Governors of the Liverpool Collegiate School, a director of North Western Industrial Estates, Ltd., and a member of many other boards and committees. He was a member of the Mersey Docks and Harbour Board from 1949 to 1955. He was born in 1889 and he became a M.B.E.(Mil.) in 1917.

Sir Leslie Nicholls was chairman of Cable & Wireless, Ltd., from 1951 until January this year, having previously been a director from 1947 to 1951 (managing director 1950-51). He was born in 1895 and was educated at Cheltenham College and University College, London. In the 1914-18 war he served with the R.A.S.C., the R.F.C. and the R.A.F. From 1939 to 1946 he held signal

Mr. G. A. S. Nairn

Sir Leslie Nicholls

commands in France, the United Kingdom, Persia and with the occupation forces in Germany. He is a K.C.M.G., C.B. and C.B.E., an Officer of the French Legion of Honour and a Commander of the American Legion of Merit; he is also a member of the Institution of Electrical Engineers.

Mr. J. W. Chalmers, M.A., LL.B., solicitor, who is at present Town Clerk of Forfar, has been appointed secretary to the Fife Area of the South of Scotland Electricity Board at Dunfermline and will take up his new duties next month.

Miss Vera Stowell has joined the Hotpoint Electric Appliance Co., Ltd., as a housecraft adviser. For some years Miss Stowell was senior demonstrator with the Cornwall Electric Power Co., leaving to become housecraft adviser with the Southern Electricity Board, Oxford, some nine years ago. She holds the E.A.W. diploma. Miss Stowell will operate from the company's head office at Crown House, Aldwych, London, W.C.2.

Mr. J. W. Potter, A.C.I.S., A.A.C.C.A., has been appointed assistant secretary of the Metropolitan-Vickers Electrical Co., Ltd. He was educated at Sir John Deane's Grammar School, Northwich, and joined the Comptroller's Department of Metropolitan-Vickers in 1941, having formerly been employed by the Northwich Building Society as accountant. His first few years at M-V were spent as senior clerk, after which he became chief clerk, lamp accounting. In 1954 he was appointed internal auditor.

Mr. N. Thorneley, M.Inst.Loco.E., has been appointed assistant chief engineer (mechanical), Traction Projects Department of the Metropolitan-Vickers Co. He received his technical education at the Manchester College of Technology and joined M-V as a draughtsman in the Traction Department in 1935. In 1949 he was appointed locomotive engineer in charge of the traction drawing office, where he has been responsible for the mechanical side of electric and other locomotive design.

Mr. R. F. Marshall, B.Sc.(Eng.), A.M.I.Mech.E., has been appointed manager of the Education Department of the company in succession to the late Mr. Kenneth R. Evans.

Mr. Marshall received his technical education at Cardiff (Technical College and University) and went to M-V as a college apprentice in 1936. In 1940 he joined the staff of the Education Department as technical assistant, became section leader, professional engineering training, in 1951, and in 1954 assistant manager for professional apprentice recruitment and training and military service. He is a member of the Stretford Borough Committee for Education,

Mr. J. W. Potter

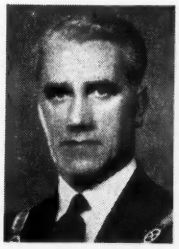
Mr. N. Thorneley

Mr. R. F. Marshall

the Further Education and Youth Advisory Sub-Commitee (Stretford), and other bodies.

Mr. E. Ward has joined Diesel Equipment, Ltd., of Uxbridge, Middlesex, a subsidiary of Auto Diesels, Ltd., as general manager.

At the annual conference of the Electrical Contractors' Association of Scotland held at Dunblane from 18th to 20th May **Mr. David G. Lindsay,** A.M.I.E.E., was elected as the Association's new president. He is



Mr. D. G. Lindsay

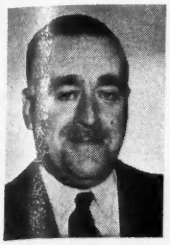
Mr. I. Sclar

principal of the firm of Alex. Lindsay, Ltd., Glasgow, and follows in the footsteps of his father, the late Mr. Alex. Lindsay, who was president during 1920-22.

Mr. Lindsay was educated at Glasgow High School and the Royal Technical College, Glasgow, and served a student apprenticeship with the General Electric Co., Ltd. He served throughout the last war in the R.E.M.E. and attained the rank of lieutenant-colonel. On demobilisation he rejoined the family firm and on the death of his father in 1950 took over the management of the business in which he is assisted by his brother, Mr. Alex. Lindsay.

Mr. Lindsay was chairman of the Glasgow and West of Scotland Branch from 1949 until 1951 and has been a member of the Central Board of the Association since 1946. He was appointed vice-president in 1954.

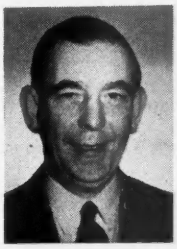
Mr. Lindsay's successor as vice-president of the Association is **Mr. I. Sclar,** M.I.E.E., managing director of Jas. Scott & Co. (Electrical Engineers), Ltd. Mr. Sclar has taken an active interest in the Association's affairs for some years and following service as chairman of the Edinburgh and East of Scotland Branch to which he was


Mr. C. L. Brown

Mr. K. H. Foulds

Mr. K. Gunney

Mr. J. L. Hurry


Mr. H. MacKenzie

appointed in 1951 he took over the chairmanship of the Joint Apprenticeship Council and has acted in that capacity for several years in addition to serving on the Central Board of the Association. At the conference many tributes were paid to **Mr. R. D. McCraith,** the retiring president.

The Ministry of Supply announces that **Mr. C. P. Fogg** has been appointed head of the Ground Radar Department, Radar Research Establishment, Malvern.

Mr. K. W. E. Gravett, M.Sc.(Eng.), of the Post Office Research Station, Dollis Hill, has been elected chairman of the London Graduate and Student Section of the Institution of Electrical Engineers for the 1956-57 session.

The **Radio Industries Club** held its twenty-fifth anniversary luncheon on 29th May at the Connaught Rooms, London. The guest of honour was the Lord Mayor of London, and

The Marchese Marconi (left) with Mr. H. de A. Donisthorpe (G.E.C.) at the twenty-fifth anniversary luncheon of the Radio Industries Club

other important guests included the Marchese Giulio Marconi, son of the radio pioneer, who is seen in the accompanying picture being welcomed by Mr. H. de A. Donisthorpe, of the General Electric Co., Ltd.

The Jackson Electric Stove Co., Ltd., has effected a reorganisation of its sales force and the following new appointments have been made:—

Mr. C. L. Brown has been appointed area sales manager, North Wales, Merseyside and North Western Board areas; **Mr. K. H. Foulds** becomes area sales manager, London, with responsibility for the areas covered by the London, Eastern, South Eastern and Southern Electricity Boards. He will continue to combine with his new duties that of public relations officer for the company; **Mr. K. Gunney** is area sales manager, South Wales; **Mr. J. L. Hurry** is appointed area sales manager, North Eastern and Yorkshire Board area; and **Mr. H. MacKenzie** becomes area sales manager, Scotland.

Mr. H. V. Schofield, M.C., M.I.E.E., has retired from active duties as sales director of the Chloride Electrical Storage Co., Ltd. His decision was announced after his recent return from a visit to the Exide factory in South Africa. He will, however, remain on the board.

Mr. Schofield joined Exide in 1914, and served in the Royal Field Artillery in the 1914-18 war, being commissioned in the field. In 1919 he returned to the Exide factory and was shortly afterwards appointed export manager. From 1920 until 1933, when he was appointed assistant sales manager, Mr. Schofield developed Exide's overseas trade and from 1933 onwards he devoted his energies to the development of the company's Sales Department in London. He was appointed a director in 1942. He is a member of the B.E.A.M.A. Council and chairman of the British Starter Battery Association. His retirement from executive duties has involved two new appointments.

Mr. E. Powell, director and sales manager of Chloride Batteries, Ltd., since 1951, now becomes general sales manager of the whole Chloride Electrical group. Associated with the company for some years before the war, he was appointed assistant sales manager in 1945 upon his return from the Forces.

Mr. A. C. Stewart, who was made assistant sales manager last year, now assumes full responsibility as sales manager of Chloride Batteries, Ltd. He has served the company since 1921, spending twenty-four of the last thirty-five years as manager of "Drydex" dry battery sales.

Belling & Lee, Ltd., announce the following appointments:—**Mr. R. S. Q. Williams** as advertising manager, **Mr. E. V. Brown** as exhibitions organiser, **Mr. R. G. B. Thornley,** sales engineer, covering the Isle of Man, all Lancashire except Liverpool and Manchester, and **Mr. G. Hetherington,** sales engineer, covering Cheshire, Flint, Denbigh, Caernarvon, Merioneth and Montgomery, Anglesey and Liverpool. Both the sales engineers will work under Mr. L. D. E. Perkins, northern area manager.

Mr. A. Salzmann, Dipl.Ing., A.M.I.E.E., who writes in this issue on "Circulating Currents in Transmission Systems," was born in Austria. Graduating at the Wiener Technische Hochschule, he served for about ten years in the technical department of the municipal electricity supply undertaking in Vienna. Following the occupation of Austria he came to this country in 1939 with the intention of emigrating to Australia, but on the outbreak of war he joined the British Army and served throughout the war. Afterwards Mr. Salzmann became a British citizen. He joined the staff of Edmundsons Electricity Corporation as relay testing engineer. Since nationalisation of the supply industry in 1948 he has been with the South Western Electricity Board.

Mr. A. Salzmann

Mr. J. Strachan, A.M.I.E.E., has been appointed technical sales engineer for Scotland for Erskine, Heap & Co., Ltd., Manchester. Mr. Strachan was until recently electrical engineer for the Scottish Machine Tool Corporation, Ltd., and has had experience with Johnson & Phillips, Ltd., and George Ellison, Ltd. He takes over from **Mr. J. C. Kelso,** who retires from this position at the end of June after thirty-three years' service.

Mr. J. Strachan

Mr. Ian T. Morrow was elected president of the Institute of Cost and Works Accountants at the Institute's annual general meeting at Edinburgh on 2nd June. Mr. Morrow is joint

managing director of the Brush Group, Ltd. **Mr. H. J. Furness,** chief cost accountant, Hoover, Ltd., was re-elected vice-president, and **Mr. J. Borsay,** chief accountant, Ferguson Pailin, Ltd., was elected a vice-president for the first time.

Mr. A. E. Percivall has been appointed a director of Blaw Knox, Ltd. He has been chief engineer of the company's Tower Department for many years.

Mr. A. E. Percivall

Mr. J. O. Hall, O.B.E., deputy chairman, general manager and chief engineer of the Electricity Authority of Cyprus, has tendered his resignation for health reasons. **Mr. J. W. Morison,** M.I.E.E., deputy chief engineer, has been appointed to succeed him. Mr. Hall left Cyprus on 21st March on retirement leave and Mr. Morison assumed duty as deputy chairman, general manager and chief engineer as from 22nd March.

The guest speaker at last week's luncheon of the **Batti-Wallahs' Society** was Admiral Sir Michael Denny, who spoke on " The Atlantic and N.A.T.O." Mr. W. C. M. Couch, the president of the Society, presided, and a vote of thanks to Sir Michael was proposed by Sir Hamish MacLaren. The next luncheon will be held on 27th June, when the principal guest will be Mr. R. Fabian (" Fabian of the Yard ").

The annual general meeting of the **Ipswich and District Electrical Association** was held recently at Electric House, Ipswich. It was reported that membership of the Association continued to grow. Interest was shown in the development of electronic applications to industry, and it was suggested that a new section should be formed to cover a definite grade of electronic engineer. Mr. H. P. Thompson was elected chairman of the Association for the ensuing year in succession to Mr. S. Hardy.

The retiring chairman of the Ipswich and District Electrical Association, Mr. S. Hardy (right) investing Mr. H. P. Thompson as the new chairman. In the centre is Mr. W. F. Rowberry, hon. secretary

On Monday the B.B.C. televised the arrival and berthing at Southampton of the *Queen Elizabeth.* One of the passengers interviewed was **Sir George Nelson,** Bt., who had returned from Canada where, as president of the Institution of Electrical Engineers, he attended the seventieth annual meeting of the Engineering Institute of Canada. Sir George said that he had represented the three leading British engineering institutions and he had also visited installations where plant made in Britain was operating. He mentioned that sixteen of the turbo-alternators which were to be installed in the St. Lawrence Seaway power scheme would come from Great Britain and he stressed the importance of this and similar " dollar " orders to this country's economy. Sir George was accompanied on his visit by **Mr. W. K. Brasher,** secretary of the I.E.E.

Mr. B. W. Burnett has been appointed secretary of the Hotpoint Electric Appliance Co., Ltd., and will operate from the company's head office at Crown House, Aldwych, London, W.C.2. Mr. Burnett was educated at Tonbridge School and King's College, Cambridge. During the war he was commissioned in the Royal Artillery and was awarded the M.C. He joined Associated Electrical Industries, Ltd., in 1947 as assistant to the secretary and was appointed assistant secretary in 1954. Earlier this year Mr. Burnett became a director of A.E.I. Estates, Ltd. He is a barrister-at-law.

Mr. B. W. Burnett

Mr. L. Rudeman, head of the Electrical Department of Staffordshire Technical College, is retiring shortly and at the recent annual dinner and dance of the College Students' and Teachers' Union he was presented with a cut-glass vase.

Over 600 parents and friends of apprentices in their first year attended parents' day at the Rugby Works of the **British Thomson-Houston Co., Ltd.** During the morning some of the guests availed themselves of the opportunity to visit the Rugby College of Technology and Arts where apprentices undergo their theoretical training. In the afternoon parents toured various factories of the Rugby Works before going to Coton House, the apprentice residence, for tea. Later, in the dining room, they were welcomed by Mr. H. E. Cox, manager, Rugby Works, who introduced the Mayor of Rugby, Alderman A. P. Broome. Dr. W. J. Gibbs (consulting engineer, B.T.H. Engineering Departments) spoke of the expansion of the electrical industry, with particular reference to nuclear energy and automation. He said that there was a great need for more apprentices and for more advanced training. After the speeches, certificates were presented by Mrs. H. E. Cox to apprentices who had achieved outstanding success. The day ended with a display by the Coton House fire brigade.

The Southern Area finals of the **Electrical Industries National Golf Championship** will be played at Brockenhurst Golf Club, Brockenhurst, Hants, on 4th July. Particulars can be obtained from the hon. secretary, Mr. L. G. Chittenden, 157-159, New Road, Portsmouth (telephone: 2031).

OBITUARY

Mr. F. W. Main.—The death occurred on 1st June at the age of seventy of Mr. Francis Walter Main, M.I.E.E., late technical director of Enfield Cables, Ltd. Mr. Main was previously for some twenty years with Johnson & Phillips, Ltd., whom he left in 1928 to join Enfield Cables as technical manager, being appointed to the board as technical director in 1943. He retired from this post in 1949, remaining on the board until he finally retired through ill-health in December, 1952.

Mr. Main was well known for his work on high-voltage cables, particularly in connection with the development of the compression cable for voltages of from 66 kV upwards. The 66 kV compression cable still in service between Hackney and Walthamstow, the first of its kind in the world, was developed under his ægis. The 275 kV cable installed at the C.E.A. Testing Station at Staythorpe is the outcome of development work initiated by Mr. Main. He was the author of a handbook on electric cables.

Mr. Robert Duncan Lawrie, foundry manager of the Distington Engineering Co., Ltd., Workington, died at his home on 25th May at the age of sixty after a long illness. Mr. Lawrie took up his appointment with the company in March, 1952, after having held positions at the works of Glenfield & Kennedy, Ltd., Brightside Foundry & Engineering Co., Ltd., and Stanton Iron Co., Ltd

Mr. A. J. Ryan.—The death occurred on 21st May, at the age of seventy-six, of Mr. Alfred J. Ryan, M.B.E., M.I.E.E., A.M.I.Mech.E., the former borough electrical engineer of Hastings. Mr. Ryan entered the electrical industry in 1897 and was appointed chief assistant engineer at Hastings in 1913. He succeeded Mr. R. Ferguson as borough electrical engineer in 1928 and retired in 1945.

BIRTHDAY HONOURS

A number of men prominent in the electrical and allied industries have received recognition in the Birthday Honours List which was published last week. From the List we have selected the names given below.

A BARONY has been conferred on **Lt.-General Sir Ronald M. Weeks,** K.C.B., C.B.E., D.S.C., M.C., T.D. Sir Ronald retired from the chairmanship of Vickers, Ltd., at the end of May, although he remains a member of the board. He is a director of a number of other companies, including Associated Electrical Industries, Ltd.

New Knights include **Mr. H. W. Clarke,** chairman of the Aluminium Industry Council, **Mr. G. H. Dowty,** chairman of the Dowty Group, Ltd., **Mr. F. J. Osborn,** director of Murphy Radio, Ltd., and **Mr. A. S. Quartermaine,** C.B.E., M.C., president of the Institution of Civil Engineers for 1951-52. **Sir Gordon Radley,** C.B.E., Ph.D.(Eng.), M.I.E.E., Director-General, General Post Office, becomes a Knight Commander of the Order of the Bath (K.C.B.), and **Mr. J. Anderson,** C.B.E., M.I.E.E., chief scientist, Admiralty Signal and Radar Establishment, Portsdown, Cosham, Hants, is made a Companion of the Order (C.B.). **Lord Hailey,** director of the Oriental Telephone & Electric Co., Ltd., and the China and Japan Telephone & Electric Co., receives the Order of Merit. **Sir Edwin Savory Herbert,** chairman of the Committee of Inquiry into the Electricity Supply Industry, is created a Knight Commander of the Order of the British Empire (K.B.E.).

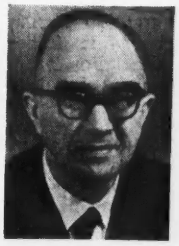
In the list of new Commanders of the Order of the British Empire (C.B.E.) are **Mr. R. P. Beddow,** executive director, British Electric Traction Co., Ltd.; **Mr. L. H. Bedford,** O.B.E., M.A., B.Sc.(Eng.), M.I.E.E., chief engineer, guided weapons division, English Electric Co., Ltd.; **Mr. T. Constantine,** chairman of Bonocord, Ltd.; **Mr. A. B. Mann,** O.B.E., chief mechanical and electrical engineer, Ministry of Works; **Mr. J. D. Peattie,** B.Sc., M.I.E.E., chief engineer, Central Electricity Authority; **Mr. J. Sullivan,** part-time member, South of Scotland Electricity Board and chairman of the Electricity Consultative Council for the South of Scotland District; and **Lt.-Colonel F. Paltridge,** D.S.C., E.D., Director of Posts and Telecommunications, Gold Coast.

Officers of the Order of the British Empire (O.B.E.) include the following:—**Mr. R. A. Browning,** Director of Contracts, United Kingdom Atomic Energy Authority; **Mr. J. Cormack,** B.Sc., A.R.T.C., M.I.E.E., principal, Bootle Technical College, Lancs; **Mr. E. W. Golding,** M.Sc.Tech., M.I.E.E., head of the Department of Rural Electrification and Wind Power, Electrical Research Association; **Mr. C. Heyes,** B.Sc.(Eng.), M.I.E.E., superintending mechanical and electrical engineer, Grade I, Air Ministry; **Mr. C. O. Horn,** B.Sc., M.I.E.E., deputy regional director, London Telecommunications Region, G.P.O.; **Mr. E. H. Jolly,** staff engineer, Engineer-in-Chief's Office, G.P.O.; **Mr. A. H. Layhe,** manager (purchasing), British Insulated Callender's Cables, Ltd.; **Mr. F. S. H. Lemon,** joint managing director, Submarine Cables, Ltd.; **Mr. H. Midgley,** M.Sc., M.I.E.E., deputy chairman, South Western Electricity Board; **Mr. S. Partington,** D.C.M., internal head of works, Salford Electrical Instruments, Ltd.; **Mr. H. G. Sturgeon,** director and chief engineer, Ultra Electric, Ltd.; **Mr. J. G. Liverman,** for services to the Volta River Project Preparatory Commission, Gold Coast; and **Mr. C. A. Britton,** general manager, Sudan Light & Power Co., Ltd.

The list of new Members of the Order of the British Empire (M.B.E.) includes the following:—**Mr. J. A. Aked,** M.I.E.E., transmission engineer, South of Scotland Electricity Board; **Mr. H. R. Canning,** manager, Marine Department, British Thomson-Houston Co., Ltd., Rugby; **Mr. H. Coward,** generation engineer (operation), North West, Merseyside and North Wales Division, Central Electricity Authority; **Mr. R. G. Ellen,** performance control engineer, Standard Telephones & Cables, Ltd., North Woolwich; **Mr. R. L. Fagg,** assistant engineer, Telephone Manager's Office, Tunbridge Wells, G.P.O.; **Mr. K. E. B. Jay,** principal scientific officer, Scientific Administration Division, Atomic Energy Research Establishment; **Mr. G. Nixon,** executive engineer, Telephone Manager's Office, Coventry, G.P.O.; **Mr. A. Shaw,** battery division sales manager, Crompton Parkinson, Ltd.; **Mr. W. T. Spittle,** lately power station superintendent, West Ham; **Mr. E. E. Frewin,** chief technical superintendent, Broadcasting Department, Gold Coast; **Mr. J. F. Leembruggen,** electrical engineer, Central Electricity Board, Federation of Malaya; and **Mr. H. W. Smith,** telephone engineer, Department of Information and Communica-

Lt.-Gen. Sir Ronald Weeks (Baron)

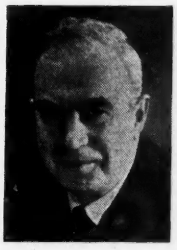
Mr. G. H. Dowty (Knight)



Sir Gordon Radley (K.C.B.)

Mr. J. Anderson (C.B.)

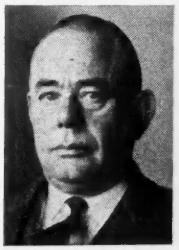
Mr. T. Constantine (C.B.E.)



Mr. J. D. Peattie (C.B.E.)

Mr. E. W. Golding (O.B.E.)

Mr. A. H. Layhe (O.B.E.)



Mr. F. S. H. Lemon (O.B.E.)

Mr. H. Midgley (O.B.E.)

Mr. H. G. Sturgeon (O.B.E.)

Mr. S. Partington (O.B.E.)

tions, British Honduras. The Imperial Service Order has been awarded to **Mr. G. Bond,** Assistant Director of Electricity and Telephones, Mauritius.

Recipients of the British Empire Medal (B.E.M.) are: **Mr. W. J. Adnitt,** charge-hand fitter, East Midlands Division, C.E.A. (Northampton); **Mr. T. Bennett,** lineman (telegraph), Class I, Crewe, London Midland Region, British Railways; **Mr. C. H. C. Brown,** foreman, Read & Partners (Newbury); **Mr. J. Burkett,** foreman electrician, Brigham & Cowan, Ltd., South Shields; **Mr. A. H. J. Colenutt,** foreman electrician, J. I. Thornycroft & Co., Ltd. (Southampton); **Mr. J. B. R. Danks,** technical officer, Engineer-in-Chief's Office, G.P.O. (Rugby); **Mr. H. C. Greaves,** inspector (engineering), Telephone Manager's Office, Sheffield; **Mr. W. A. Harvey,** storekeeper, South Eastern Division, C.E.A. (Southwick); **Mr. J. Hopper,** crane driver, North Eastern Division, C.E.A. (Newcastle-on-Tyne); **Mr. J. Irwin,** fitter, Sirocco Engineering Works, Davidson & Co., Ltd., Belfast; **Mr. F. A. Moody,** electrician's mate, s.s. *Pretoria Castle*; **Mr. H. C. Page,** fitter, East Midlands Division, C.E.A. (Nuneaton); **Mr. L. Parry,** Meter Department foreman, South Eastern Electricity Board (Mitcham); **Mr. C. Ll. Roe,** technician, Class I, Post Office Telephones, Carmarthen; **Mr. W. Starr,** toolroom foreman, Pulsometer Engineering Co., Ltd., Reading; **Mr. W. F. Steers,** inspector, Telephone Manager's Office, City Area, London (Barnehurst); and **Mr. G. Thomson,** tipper and coal checker, Clyde's Mill generating station, South of Scotland Electricity Board (Carmyle, Lanarkshire).

Mr. J. A. Aked (M.B.E.)

Mr. H. R. Canning (M.B.E.)

Mr. H. Coward (M.B.E.)

Mr. A. Shaw (M.B.E.)

PARLIAMENTARY REPORT

IN the House of Lords, Lord Vansittart asked what were the advantages or disadvantages which would accrue to countries other than Egypt from the construction of the High Dam at Aswan, and in financing a project for a hostile Egyptian regime.

The Marquess of Reading, Minister of State, replied that the Government, in offering to take part in the international scheme to finance the Dam, had accepted the views of experts that the project was an essential part of any overall scheme for developing the Nile water resources. It was not a matter of financing a particular regime; it would have a lasting effect on the economy and living standards of Egypt, whatever Government was in power.

Decision to Abandon Trolley-buses Criticised

During the discussion on the Road Traffic Bill in the Commons, Mr. Ronald Bell moved a new Clause to ensure that after January, 1965, no diesel vehicle should be used in the Metropolitan Police District. He said he moved the amendment because the London Transport Executive had decided to replace 1,800 trolley-buses by diesel vehicles. (Cries of "Shame!") He agreed with those who condemned this proposal, which had caused much concern to people interested in the health of people in the Metropolis.

Action had been taken to deal with pollution of the air by smoke from chimneys, but nothing was done about the fumes from diesel engines which, coming out of the vehicles a few inches from the ground, were trapped in the narrow, canyon-like streets until they reached an appalling concentration. Since diesel buses had become general in London, windows had been coated with a film of oil and it had been shown that benzpyrene, a constituent of diesel fumes, was a cancer-producing agent. The British Medical Association had told the Minister of Transport that it "viewed with alarm the replacement of the electric trolley-buses." The attitude of the Minister seemed to be that since the air of London was already heavily polluted another 2,000 diesel buses would not make any difference.

Mr. Arthur Palmer, seconding the motion, said he also believed the increase in diesel vehicles was a menace. There was ground for grave suspicion that diesel engine fumes were a danger to health. For large-scale passenger transport electricity was cheap, convenient and completely clean. If the trolley-bus was not popular with some experts of the London Transport Executive, it was with the people who used it. Another advantage of the electric passenger vehicle was that the energy used was produced from home sources.

Mr. Palmer referred to the fact that electricity and transport was the main theme at the 1956 British Electrical Power Convention, and that the discussions centred upon the great part that electricity would play in the electrification of the railways. It would be ironical, he said, if the railways were to become cleaner through the use of electricity while the streets became dirtier through the extended use of oil fuels.

Mr. Hugh Molson, Parliamentary Secretary, Ministry of Transport, replying for the Government, said the Clause would have a revolutionary effect because 94 per cent of the buses, 49 per cent of the taxis and 54 per cent of the heavy goods vehicles registered in London were propelled by diesel engines. As yet, there was no evidence that diesel fumes had any measurable effect on those who breathed them. Unless and until this was proved it would be impossible for the Government to accept the Clause.

After further discussion the new Clause was withdrawn by Mr. Bell. He said he did so after "a completely unsatisfactory reply" from Mr. Molson "and out of quite undeserved pity for London Transport."

Tax on Export Order Forms

Mr. Leather asked the Financial Secretary why overseas buyers were charged purchase tax on their own order forms, printed and purchased in their own countries, and used for the sole purpose of placing their own orders with British exporters.

Mr. Brooke replied that under the law these order books were liable to purchase tax as stationery, whether they were made here or imported. It would be quite wrong to make arbitrary exceptions in particular cases of this kind.

Information on Research

In reply to Mr. Kenneth Thompson the Parliamentary Secretary to the Ministry of Works (Mr. Bevins) said that research associations in receipt of grant aid were advised to make information available as widely as possible without prejudicing the welfare of their own members and of the industries they served. Answering a further question, he said that these research associations were autonomous bodies and the Government was in no position to dictate to

them what they should do. It was desirable that information should be disseminated widely, but it was also desirable that the associations should stand more on their own feet financially and the supply of information from research associations was an incentive to people to become members.

Underground Coal Gasification

Replying to Mr. Ridsdale, the Minister of Fuel and Power (Mr. Aubrey Jones) said that the development of the technique of underground gasification of coal had now reached the point at which the establishment of a pilot scale plant was desirable. The National Coal Board and the Central Electricity Authority had as from 1st July accepted responsibility, within their respective spheres, for the planning and construction of this pilot plant and had undertaken to explore the possibilities of exploitation on a commercial scale. Details of the transition to these new arrangements were now under discussion between his Ministry and the two authorities. He had indicated to both of them the importance of developing with the utmost expedition this important new technique, as well as his wish that private enterprise should be associated with the work, particularly so that full advantage of it could be taken in overseas markets.

Mr. Ridsdale asked why the Minister had not been able to entrust the whole of this work to private enterprise.

Mr. Jones replied that as the Statute now stood the National Coal Board was the sole authority responsible for the exploitation of the coal resources of the country. Further, it was desirable that one authority should determine which coal deposits should be exploited by mining and which should be exploited by underground gasification. For that reason he considered it right that the ultimate responsibility should be given to the Coal Board, but, subject to that ultimate responsibility, he hoped that the Board would be able to devolve on private firms as much as it could of the operating work.

In an explanatory note, the Ministry stated that some time would elapse before the commercial possibilities of this project could be confirmed. Even when a successful pilot plant had been constructed it would inevitably be some years before full-scale commercial plant could be brought into operation.

Details of the investigations in underground gasification carried out by the Ministry and the N.C.B. were given in the *Electrical Review* of 18th November, 1955.

Price of Coal

Mr. Osborne asked the Minister what general directions, under the Coal Industry Nationalisation Act, he was considering to stabilise the price of coal since it was not possible to control inflation while coal prices continued to increase because they determined so many other prices such as gas, electricity and transport.

Mr. Jones said the course of coal prices must of necessity be determined by the trend of production costs, and these were not susceptible to control by Ministerial direction. He had, however, impressed on the National Coal Board the importance of increasing productivity so as to enable any unavoidable cost increases to be absorbed, and it was partly in order to give an impetus to productivity that he had approved the Board's revised and extended development plans.

Atomic Power Programme

Mr. Chetwynd asked the Minister of Fuel and Power what action was now being taken to accelerate the programme for the development of atomic power plants.

Mr. Aubrey Jones said he believed that in due course it would be possible to accelerate the original nuclear power programme, but until plans for the design and construction of the first nuclear power stations had been received from industry and considered by the Central Electricity Authority, no firm reappraisal of the programme was possible. These plans were due to be submitted this autumn.

Trade with Brazil

Mr. Kenneth Thompson asked the President of the Board of Trade if he would initiate discussions with the Government of Brazil with a view to creating conditions in which increased trade could be expected.

Mr. Low, Minister of State, said that following discussions with the Governments of the United Kingdom, Federal Germany and the Netherlands, the Government of Brazil in August last instituted multilateral trade and payments arrangements with those countries. Belgium, Luxembourg and Italy had since become parties. These arrangements had widened the scope for our exports and he did not think that bilateral trade discussions were at present necessary.

Association of Electrical Machinery Trades

THE annual meeting of the Association of Electrical Machinery Trades was held on Monday last at St. Ermin's Hotel, London.

The annual report of the Council submitted at the meeting expresses disappointment that while the number of firms supporting the Association has been maintained, the number has not been substantially increased and urges members to enlist the interest and support of more firms in the trade. The Association's fortnightly bulletins now embrace variations in manufacturers' prices, details of Government legislation affecting the industry, general commercial information and trends in copper prices. Its journal, "Electrical Machinery," increases in popularity, but the Council appeals for increased contributions from members.

Dealing with technological education, the report says that the question of courses for fitters and armature winders has been reopened with the City and Guilds of London Institute and it is hoped that before long four-year courses will be introduced by the Institute covering a fitters' course for the first three years and a special armature winders' course for the fourth year. The Association's brochure on apprentice training within the industry has been in great demand.

Arrangements have been made with the National Boiler and General Insurance Co., Ltd., for a scheme of insurance with special rates for Association members to cover the liability of members for breakdown during the guarantee period. The standard of conditions of trading recommended by the Association is being amended and members will be notified of the new wording in due course. Reference is made to the success of the annual dinner and dance and of the annual Convention held at Southport.

At the meeting Mr. A. H. Spindler (A. Cooksley & Co., Ltd.) was elected chairman of the Association for the ensuing year in succession to Mr. F. H. Washington and Mr. H. Vernon (Thos. W. Ward, Ltd.) was elected vice-chairman. The meeting was preceded by an informal luncheon, at which Mr. Washington welcomed members and guests and expressed the Association's thanks for the support accorded to it by the technical Press.

NUCLEAR RESEARCH REACTOR FOR GERMANY

Associated Electrical Industries, Ltd., announces that the A.E.I.-John Thompson Nuclear Energy Co., Ltd., has received an order for a research reactor from the German Ministry of Economics and Transport. The reactor, of the "swimming pool" type, will be capable of operating at heat outputs of up to 5 MW. This is the second "MERLIN" (medium energy light - water - moderated industrial nuclear reactor) to be built by the company, the other being for the A.E.I. Research Laboratories at Aldermaston Court. The reactor for Germany will be the same as that for Aldermaston in the design of the core, reactor tank, control gear and instrumentation and in the experimental facilities provided. The provision of the enriched uranium fuel required does not form part of the contract.

In the Courts

London Board Employees' Claim

AN action which provides an echo of the meter readers' strike in 1952 was begun in the High Court before Mr. Justice Pearson on 29th May and was continued on succeeding days. Two employees of the London Electricity Board, Mr. L. C. W. Ardley, a meter reader, and Mr. N. W. Morey, an electrician, claimed against their employers the sums of £38 and £41 respectively which, they alleged, were due to them under the Board's co-partnership scheme. The Board's defence was that the plaintiffs were in breach of their terms of service in that they went on strike without notice in January, 1952, thereby forfeiting their rights under the scheme. The plaintiffs' reply was that it was a term of the settlement of the strike that no deductions from payments due under the scheme should be made by reason of the strike.

A Test Case

Mr. D. N. Pritt, Q.C., in opening the case for the plaintiffs, said that this was in substance a test case covering fewer than one hundred men. What he described as the "core" of the case was that on 1st January, 1952, there was a strike of meter readers employed by the Board. On 22nd January there was a meeting at the Ministry of Labour and National Service under the chairmanship of Sir Robert Gould, the Chief Conciliation Officer. The outcome of that meeting was a settlement, one of the terms of which was that the Board should not refuse to pay a co-partnership bonus which otherwise, by reason of the strike, they might be justified in doing. Some months later the Board refused to pay the bonus. Sir Hartley Shawcross, Q.C., for the Board, said that the defence was that no such agreement had been come to.

Continuing his opening, Mr. Pritt then went into the causes of the strike, alleging that because of the employment of "snoopers" by the Board the men had become annoyed and that, as the Board had refused to withdraw them, they had come out on strike. Mr. Pritt also referred to the Press statement issued by the chairman of the Board (Mr. H. J. Randall) on 16th January, saying that by that statement the chairman had done his best to make any agreement impossible. His Lordship questioned whether this had anything to do with the point at issue and Mr. Pritt replied that it was necessary that the background of the case should be given.

The plaintiffs then gave evidence. Mr. Ardley was a meter reader at Hammersmith and he had come out on strike at the beginning and had stayed out until the end. He had gone back to work after the strike believing that he would not lose any money. In reply to a question by Sir Hartley Shawcross, he said that he had been chosen by his union as a plaintiff because he had not been in trouble or off work since he started in 1928. Mr. Morey said in evidence that, although he was an electrician and not a meter reader, he felt very strongly about the matter and for that reason had come out on strike for one day in sympathy. He agreed with Sir Hartley that his action was a temporary breach of his service agreement with the Board, though "only a small one."

Mr. Maurice Ward, an official of the Electrical Trades Union, after giving evidence as to the employment of "snoopers" by the Board, was closely cross-examined by Sir Hartley about the settlement which was arrived at at the meeting on 22nd January, 1952. Reference was made to a Press statement prepared at the meeting and to a "gentleman's agreement" arrived at before that statement was prepared, and the witness said that he considered the "gentleman's agreement" to be more important than the Press statement. He understood that there was to be no victimisation and he regarded the non-payment of the bonus as a breach of that agreement; but he agreed with His Lordship (in answer to a question) that it was more important to the men that they should keep their jobs than whether or not they should be paid a bonus, because the co-partnership scheme affected only about a third of the men. Asked about the fact that there was no mention of the co-partnership scheme agreement in the minutes of various Joint Industrial Council meetings, the witness said that the "gentleman's agreement" could not be mentioned without the authority of those who had made it. This drew the comment from Sir Hartley that if it were thought that the Board had broken the agreement there was no reason why it should not be made public. To a suggestion that there was Communist infiltration in the Union, the witness replied that it was correct that in 1952 the president, the general secretary and the assistant general secretary of the Union were members of the Communist Party. He denied, however, that the Union operated a closed shop and could not recall that there had ever been a strike in London on the question of non-unionism.

On Monday Mr. F. Foulkes, general president of the Electrical Trades Union, gave evidence. Asked what he understood by the term "No victimisation," he replied that it meant that the men should go back on precisely the same terms of employment as before they came out on strike. The term was always put into settlements of disputes, otherwise no settlement would be possible. The Union did not pay strike pay in respect of the January, 1952, stoppage because it was not an authorised strike. Cross-examined, he said he could not agree that the Union had more unofficial strikes than any other in proportion to its membership.

Asked his view of men who behaved in the way that some of the meter readers were alleged to have behaved, one conducting a café, another a dog track and another "knocking off" at 11 a.m., Mr. Foulkes said he would regard them as very bad citizens and such behaviour would call for prompt sacking.

His Lordship asked how the Board could get proof unless they employed checkers. Mr. Foulkes said the best way would be to discuss it with district officials of the Union who might be able to suggest a method which was not so obnoxious.

Farmer Awarded Damages

Mr. C. Harland, a farmer, of Ellerbeck, Yorks, was awarded £143 damages against Mr. A. Grimston, electrical engineer, at the Northallerton County Court on 30th May. The plaintiff stated that some of his cows received shocks when he switched on a milking machine and two of them were killed. He claimed that the defendant has been negligent in not testing the earthing of the system which he had installed.

A witness stated that the earthing through water mains was ineffective because there was a length of plastic piping where the water supply was taken under a bridge.

Mr. Grimston said that he presumed that the galvanised water pipes on the farm would provide an effective earth; he did not have his testing apparatus at the time. His solicitor submitted that the damage was caused by builders who had carried out work at the farm.

PRICES OF MATERIALS

In the accompanying table we give the basis prices of the more important materials used in the electrical industry. The figures given are the selling prices and are those quoted on Tuesday last.

ALUMINIUM Ingots	ton £189 0s 0d
COPPER, H.C. Electro	ton £295 5s 0d
Fire Refined 99·70%	ton £294 0s 0d
Fire Refined 99·50%	ton £293 0s 0d
COPPER Tubes ..	lb 2s 10½d
Sheet	ton £364 15s 0d
H.C. wire and strip ..	ton £328 15s 0d
LEAD, English ..	ton £109 15s 0d
Foreign	ton £108 0s 0d
MERCURY	flask £87 0s 0d
TIN, block (English) ..	ton £724 10s 0d
ZINC, G.O.B. Foreign	ton £91 15s 0d
Electrolytic	ton —
BRASS Tubes (solid drawn)	lb 2s 4½d
Sheet	ton £295 0s 0d
Wire	lb 3s 0½d
PHOSPHOR BRONZE Wire	lb 4s 5½d
PLATINUM	oz £34 0s 0d
RUBBER, No. 1 R.S.S. spot	lb 22⅝d—22¾d

Electrical Forum

Power Convention Panel Answers Delegates' Questions

ON the last day of the British Electrical Power Convention at Torquay the usual Electrical Forum was held at which questions sent in by delegates were answered by a panel of well-known people in the industry who had not seen them beforehand. The panel consisted of Mr. D. Bellamy, Mr. Norman Elliott and Sir Henry Self from the supply side and Sir Vincent de Ferranti, Mr. S. E. Goodall and Mr. H. H. Mullens as manufacturers, the President (Sir John Dalton) acting as question master.

In the first question the panel were asked for their views on the recommendation in the Herbert Report that the supply industry should invite tenders from abroad.

Sir Vincent de Ferranti thought it deplorable that the Herbert Committee should have tried in this way to throw a spanner into the works of the very happy and co-operative electrical industry. Presumably, it was thought that the manufacturing industry in this country made too much profit, but the balance-sheets of the companies concerned would show that their profits, far from being unreasonable, had not been sufficient to finance the equipment which they required to serve the supply industry.

Mr. Elliott said that no one would wish foreign countries to slam the door against British goods, but we could hardly expect them to buy from us if we were unwilling to buy from them. In his view if the prices of foreign manufacturers were comparable, if delivery was comparable, if—and this was most important—the conditions and standard of living of the workers in the foreign factories were comparable with those here, and if the foreign country admitted British goods, we should invite tenders from abroad, and might even occasionally buy abroad, because reciprocity was important.

In the view of Mr. Mullens, on the other hand, the recommendation was absolute nonsense unless subject to certain qualifications. There must be proper reciprocity. It would be crazy to spend dollars on plant which could be made just as well in this country. It was difficult to decide whether foreign tenders were fair, because certain companies abroad might reduce their prices to an absurd figure in order to get into the British market.

Mr. Malenkov's Visit

The panel were next asked for their views on the visit of Mr. Malenkov and the Russian power engineers, and of the return visit by Lord Citrine and representatives of the British supply industry.

Sir Henry Self, speaking as one who had been mainly a spectator, felt sure that the visit of the Russians to this country had done an immense amount of good. Lord Citrine had a flair for this sort of thing; the arrangements had been entirely his and had been extremely successful. The reciprocity of approach and outlook which resulted had been carried over to the return visit, and the engineers who took part in both visits had derived an astonishing amount of mutual advantage. He had the impression that the Russians were well to the fore in matters of technical advance and development, but were neither as cost-conscious nor as keen on "spit and polish" as we were. The exchange of visits had been abundantly worth while.

Mr. Bellamy emphasised the value of such contacts, because "what you can see you are not afraid of," and Mr. Goodall, while agreeing with all that Sir Henry had said, urged the need to be a little cautious and not to expect too much from these exchanges.

Gas-Electricity Competition

The next question was whether the continuing practice of laying gas mains all over the country, which was already covered with electric cables, was not "a wicked waste of money," and whether it would be a good idea for Area Boards and Gas Boards to occupy offices in the same building and have joint showrooms and service centres.

Mr. Bellamy agreed that to bring supplies of both electricity and gas into houses might seem wasteful, but suggested that in a free and democratic country the consumer might claim freedom of choice. In the end he thought that economics would justify the elimination of gas mains, but this should be an evolutionary rather than a revolutionary change.

Mr. Goodall, however, took the view that a degree of competition between the two industries was the only way by which the consumer could ensure some measure of efficiency in both.

Mr. Elliott felt that joint showrooms and joint service centres were of great value to consumers and that it was a good thing that a consumer should come to a joint showroom to pay his gas and electricity accounts and to see gas and electrical apparatus in the same showroom. In agreement with the chairman of the South Eastern Gas Board, and in spite of the objections of the commercial departments of both Boards, such a joint showroom had been established at Sandwich and worked extremely well, and they had another at Cranleigh. An inquiry had been made into joint meter reading, but it had been decided that this would not be economic.

Coal and Atomic Energy

The panel were next asked whether the vast capital expenditure envisaged by the Coal Board for the next ten years would not be better employed if diverted to the development of atomic energy power stations.

Mr. Mullens pointed out that the figure which had been announced, of £1,000 million, sounded impressive, but would mean £100 million a year as compared with the £93 million spent by the Coal Board last year. The country must make the best use of its dwindling coal resources and it would be very unwise to cut down the contemplated expenditure.

Sir Henry Self felt that the question misfired completely, because it assumed that by putting the £1,000 million into atomic energy the programme outlined in the Government White Paper could be speeded up. The White Paper envisaged that by 1965 nuclear power stations would produce between 1,500 and 2,000 MW, which was the equivalent of one year's new commissioning. It was not yet known what snags would be encountered or how fast the rate of technical development would be; it might make a station obsolete almost before it had come into use. His guess was that atomic energy production would be something like 4,000 MW a year about 2000 A.D. In the meantime the supply industry must depend on coal and without the projected expenditure on the mines it would be unable to obtain the coal that it required.

Mr. Elliott, refuting the commonly held idea that because

of the advent of nuclear energy there was no need to worry about coal any more, said that to get electricity in quantity and economically from atomic energy was going to be a Marathon, not a 100-yard sprint.

Mr. Goodall agreed that the answer to the question was "No." For many years coal would be required on an increasing rather than a decreasing scale.

District Autonomy

Another question asked for the views of the panel on the Herbert Committee's recommendations regarding district autonomy.

Mr. Elliott accepted the underlying principle. The consumer went, he said, to the district manager, who should be able to give answers on behalf of the Board, and if consumers questioned their account the district manager should be able to put things right and tell the accountants what to do, instead of the accountants telling him. The Herbert Committee's suggestion that the new Central Authority should have very wide powers over the Boards did not fit in with their recommendation that the districts should run their own affairs. A district could not alter its tariffs without consulting the Board, but should not have to refer to headquarters more than was strictly necessary.

Mr. Mullens said that where there was a simple radial system in an area there would probably be districts which were largely autonomous in the sense that the amount of energy going into the district was known and it could make its own arrangements without disturbing the position elsewhere. In a highly industrialised area with a complex interconnected system, however, the position was entirely different, because a district which "went off on its own" might cause a number of collieries to shut down somewhere else. He agreed, however, that the greater the autonomy which could be given to smaller portions of an organisation the healthier it was.

Mr. Bellamy emphasised that the benefits of large-scale organisation must not be sacrificed, but said that there should be no difficulty if policy and administration were determined by the Area Board but the man on the spot was the executive operator, and able to say yes or no. The Herbert Report might do a good deal of harm if it was not properly understood.

Shortage of Technicians

The next question related to the shortage of technicians and what could be done to overcome it.

Mr. Goodall suggested that any major increase in the supply of technologists and technicians must depend on more and better quality science teaching in the schools. There was a shortage of science masters and science mistresses—he mentioned science mistresses deliberately, feeling that the time had come to have more trained women in the industry—and even the amended Burnham scale was still inadequate to attract them. It was also essential to make the best use of the technical personnel available.

Sir Henry Self mentioned that the supply industry had relied greatly in the past on men who had come up "the hard way" and must continue to give them every opportunity.

On the question of technicians, Mr. Elliott said one difficulty was that at the age of 11+ three-quarters of the boys and girls were sent to secondary modern schools, and a sort of stigma was attached to that. It was reckoned that at least half of them could become technicians or better, but only one-eighth of them did so. One large education authority in S.E. England was inaugurating a scheme by which a number of boys and girls in secondary modern schools would be nominated by their headmasters at 15 to go for a year to a technical college and then enter an apprenticeship, taking the National Certificate or a new City and Guilds certificate which would be a little below H.N.C. standard.

National Inspection Council

The panel were then asked what were the functions of the National Inspection Council and whether its cost was justified.

Mr. Bellamy said that the Council was intended to do what the industry had been trying to do for the last forty years but had not been able to do for lack of agreement. It was hoped to evolve standards which would ensure that the people who did the work would not require so much watching and inspecting, because it was a serious matter for Area Boards to have to inspect every installation which was put in.

Mr. Goodall said that the members of the I.E.E. Wiring Regulations Committee were well aware that, despite their efforts to produce satisfactory standards for house wiring, when they went home they did not find them. They therefore welcomed the formation of the Council as a practical step to ensure that proper standards were maintained.

Sir Henry Self mentioned that the cost would be about £56,000 per annum.

Financing Research

The next question referred to the appeal made at the Convention for funds for the E.R.A., and asked whether such appeals could not be avoided by an agreed quota allocation on the supply and manufacturing sections of the industry.

Sir Henry Self contended that the manufacturers were not paying their proper quota. There was a shrinking D.S.I.R. contribution, a mounting supply industry contribution, and a static manufacturers' contribution of what he described as "a quite infinitesimal character." He was all for backing the E.R.A., but the D.S.I.R. should not pull out and it was high time the manufacturers pulled in.

Mr. Goodall said that the manufacturers contributed heavily not only in money but in resources, a great deal of E.R.A. research work being done in their laboratories. He felt, however, that not enough use was being made of the Association, and that by pooling research resources through the E.R.A. and in other ways they could save scientific manpower. There were defects in the organisation of the Association which caused some hanging back; it was committee-ridden, and more responsibility should be delegated to individual experimenters.

Mr. Elliott said the trouble was that manufacturers spent large sums on research, each working in his own corner and not telling the others what was being done, so that the work was duplicated and quadruplicated, whereas the supply industry made a handsome contribution to the E.R.A. and the results were available to everybody.

Sir Vincent de Ferranti emphasised that the E.R.A. were doing only "a tiny little bit" of the research of the industry and rendering a service which, while valuable, was insignificant in relation to the whole.

Mr. Mullens complained that the attitude of the D.S.I.R. in reducing its contribution meant that if industry was generous the E.R.A. did not in the end benefit, because the D.S.I.R. withdrew support accordingly.

On two other questions dealt with, the panel took the view that the granting of trade terms to staff, to which some chambers of trade objected, was merely a question of acting as a good employer and continuing an established tradition in the supply industry, while on automation the general view seemed to be that this was nothing new and that its introduction must necessarily be gradual.

The Minister of Industry addressing the delegates, who are seen in the lower illustration

C.I.G.R.E.

LARGE HIGH-VOLTAGE SYSTEMS

THE sixteenth International Conference on Large Electric Networks (C.I.G.R.E.) opened in Paris in the afternoon of 30th May and concludes to-morrow (Saturday).

At the opening ceremony, which was presided over by the Minister of Industry, Dr. R. A. Schmidt (president, C.I.G.R.E.) welcomed the delegates and expressed appreciation of the interest in the Conference shown by the Minister, who briefly responded. Dr. Schmidt then paid a tribute to the work done over many years by the late Col. Mercier, formerly president and more recently honorary president. He then outlined the activities of the organisation.

Two short speeches were delivered by Messrs. De Bast (Netherlands) and B. Buckert (Finland) on behalf of French-speaking and English-speaking delegates, who represented 44 different countries. Mr. J. Tribot Laspière (vice-president and general delegate) expressed thanks on behalf of his staff and himself for the commendatory references made by previous speakers to the manner in which this and earlier conferences had been organised, both technically and socially. The technical proceedings included discussions of 117 papers.

Earlier in the day the 75th anniversary of the first international congress on electricity, held in Paris in 1881, was celebrated by a formal ceremony arranged by the Société des Electriciens. The congress is memorable as the occasion on which it was decided to establish international electricity standards.

Transformer Production Tests

Technical sessions started the following morning with parallel meetings on transformers and on overhead lines. Regarding transformers, the main theme was given by the chairman (Norris, Ferranti) of the appropriate study committee which sponsored three papers. These related to production tests of on-load tap-changers, transformer noise and chopped-wave impulse testing. A fourth subject, short-circuit problems from the manufacturers' points

of view, was referred to in a special report (Berthelot, France).

The first (by Rippon, C. A. Parsons & Co.) reported a majority view of the committee in favour of dielectric testing of transformers and tap changers as a combination but treating the latter alone in the establishment of ratings. Thermocouple measurements were regarded as more precise than contact resistance values. Temperature rise of the contact face should be limited to 10 to 30 deg in excess of that of the oil at continuous rated output. Short-circuit current appropriate to the tap-changer rating should be applied five times without appreciable time lag between each.

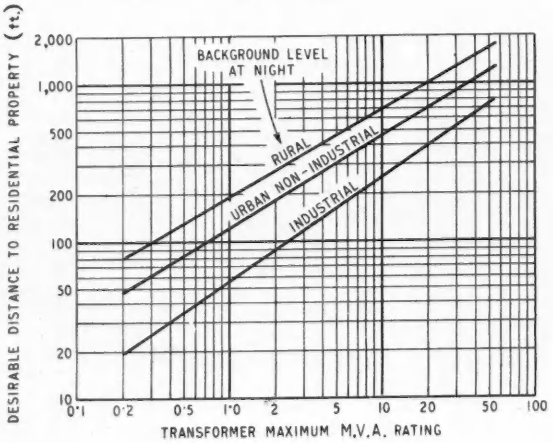
Reactors must be designed to avoid high inrush currents during switching but no definite conclusions were reached about relating maximum switching currents of high-speed resistors to the type-rating of the tap-changer. In routine tests the tap-changer should be operated a reasonable number of times with the transformer excited but on open circuit. Reductions of 30 to 40 per cent of impulse voltages across the tapping range had been achieved by non-linear resistors with some types of winding.

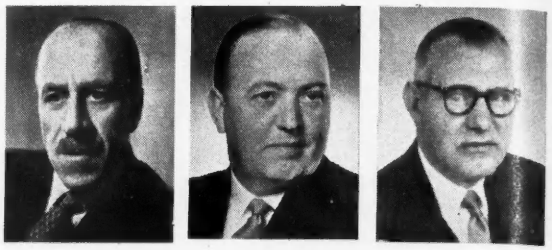
Noise Suppression

Transformer noise was considered under three main headings of site, transformer design and installation (Tobin, Hackbridge & Hewittic). In general the sound level measured in decibels outside a residence should not exceed 33 in rural areas, 40 in urban areas and 48 in industrial areas. Transformer noise should add less than 3 dB to the background sound level. Adjacent buildings might influence concentration or direction of sound, which could be amplified by reflection and resonance if transformers were placed in cells having one side open. The nature of the subsoil affected the sound level and the vibration transmitted. The sound level of transformers of all makes in different countries was similar and no fundamental improvement had been noticeable during the past twenty years. Its value appeared to be determined mainly by quantity of core steel and induction density; its causes were magnetostriction and transverse vibration, in about equally important parts.

Any small reduction of magnetostriction through lowering induction density was offset by increase in core material and became uneconomic and impracticable; similar considerations applied to special designs. The more practicable method was to build walls all round a transformer, leaving only enough space for operation with

Fig. 1.—Minimum desirable installation distances for unscreened transformers





E. T. Norris *E. C. Rippon* *E. Tobin*

a roof (through which the bushings projected) close to the transformer cover. Transformers should not be mounted on wheels or rails but on oil-resisting rubber mats on the foundations.

Another paper analysed sound-level measurements on 140 transformers of 200 to 60,000 kVA (Brownsey, Glover & Harper, C.E.A.). This supported the conclusion of the previous author that external suppression of noise at present provided the most satisfactory solution. Minimum distances desirable (40 dB weighting) between unscreened transformers and residences were as shown in Fig. 1. At that weighting average levels for any size of transformer with a maximum flux density of 13,500 lines/cm^2 were $14 + 13{\cdot}5 \log_{10}$ (kVA). The greatest percentage of transformer noise energy was at 100 c/s having a wave length in air of 11ft, which was generally the highest effective height of screening walls. Coating the walls internally with a sound absorbent at 100 c/s was of little advantage.

The purpose of chopped-wave impulse testing was stated (Stenkvist, Sweden) to be to check the ability of the insulation between turns and coils to withstand the higher stresses imposed on the first part of the winding by chopped waves produced at flashovers to earth close to the transformers. The intention was not generally to cope with full waves corresponding to standard insulation levels. The need for the test depended upon the type of protection used.

Assuming a chopping time of the gap consistent within 0·1 microsecond, chopped-wave testing could be regarded as satisfactory and current oscillograms could be compared to determine whether a fault had occurred (Preston, Ferranti). The test, however, needed apparatus and technique of higher standards than that for full-wave testing. With the probable adoption of a chopped-wave voltage level equal to that of the full wave, the test appeared to represent a step forward.

Impulse testing with a wave of reduced steepness was discussed (Langlois-Berthelot and colleagues, France). The front duration should be at least six times that of the complementary full-wave test and be sufficient to make the line current free from appreciable capacitive high-frequency components. A value of 10 microseconds led to stresses closely approaching those due to chopped waves in working conditions.

The importance of maintaining wave shape in impulse tests was emphasised (Fruidevaux and Rossier, Switzerland). Existing standards relating to short-circuit tests on modern very large power transformers were criticised (Stenkvist and Torseke, Sweden) as impracticable, mechanically and electrically. The avoidance of too great a reactance variation for different selector positions with on-load regulation of transformers installed for interconnecting two systems of different voltages was much more difficult with auto-transformers than with transformers of the two-winding type (M. Christoffel, Switzer-

C. M. Brownsey

I. Glover

G. B. Harper

land). An arrangement of windings for a 225/150 kV auto-transformer to meet these conditions was described.

Overhead Line Economies

For the alternative programme on Thursday (overhead lines) the chairman of the study committee (Silva, Italy) reported on investigations in hand regarding economies possible in construction costs. His report also referred to preliminary work in assessing the importance of everyday stress and strain on paying out pulleys. The diameter of the groove should fit closely to that of a.c.s.r. conductors to avoid penetration of the aluminium strands by the steel strands (Avril, France).

An appendix to the report (Poyart, France) dealt with the three factors that determined the dimensions of the upper parts of line supports (except anchoring towers), viz. length of insulator strings, their deflection by wind and the distances between live parts and supports. These were discussed in relation to insulation levels and to the conditions under which such levels must be maintained. A modern system with directly earthed neutral seemed to be subject to over-voltages not greater than three times the phase-to-neutral voltage. Experiments were being carried out on the French grid (by Cabanes) to ascertain the feasibility of adopting a lower insulation level than $U\sqrt{3}$. Lengthening insulator strings hardly affected frequency of flashovers in thunderstorms and appeared to have no advantage in drizzle or fog.

Experiences described by engineers from a number of countries indicated that the wind pressure on overhead lines was well below that hitherto generally assumed, since its intensity varied over the normal length of a span. Bundle conductors showed an advantage in regard to wind and ice loading over single conductors (Mors, Baer and Erich, Germany).

Tests carried out in Victoria (Harrison) supported the view that a greatly reduced coefficient relating wind velocity to pressure on conductors could safely be adopted. The results accorded with those found independently in Sweden, which had led to the adoption of a coefficient only 30 to 50 per cent of those in many other countries. A wind-load criterion for ice-free conditions in Victoria was fixed at 7·5 lb/sq ft at 40° F.

From particulars given (Bowling) of the design of the first 330 kV lines in New South Wales, more severe conditions had to be allowed for, and an effective wind pressure of 27 lb/sq ft, equivalent to 70 per cent of the gust pressure had been taken. These lines ran for 240 miles from the Snowy Mountains hydro-electric scheme to Sydney at altitudes varying between 5,200ft and sea level, those above 3,000ft being regarded as ice areas; thus a common design basis for the whole length was not economically possible.

Reductions in material and operating costs consonant with safety were being effected in Canada (Crowley) through modifications in design and construction suggested by long operating experience as well as by present research. Wood structures treated with modern preservatives offered substantial savings up to 230 kV. All-aluminium conductors were cheaper than the steel-reinforced type, but the sag was greater, entailing higher structures or shorter spans. Other factors for and against a more extended use were being investigated. Present indications were that bundle conductors should be considered where more than 100 MW had to be transmitted further than 250 miles at 230 kV and above (60 c/s). There was now a greater trend towards the use of double-circuit lines.

High-Voltage D.C. Transmission

Only two papers were presented for discussion at the meeting allocated to high-voltage d.c. transmission. The first was a report from the appropriate study committee (Rathsman, Sweden) in which reference was made to an experimental 112 km 200 kV line of 30 MW capacity, which had been on trial in the U.S.S.R. since 1951, with a view to the possible use of d.c. for the long distances between power centres in that country.

F. J. Lane

Two communications relating to progress in Japan (by Yamada and by Saeki), which were included as appendices, seemed to indicate that d.c. under conditions prevailing there could compete with a.c. more especially because of the different frequencies in use.

The practicability of earth return for long overland d.c. transmission was an important economic factor. Prevention of possible corrosion by cathodic protection and limitation of interference were now under consideration. The magnetic effects of single-core cables on ships' compasses in much navigated waters was being studied by a working committee composed of Lane (G.B.), Belfils (France) and Lamm (Sweden).

Since the last C.I.G.R.E. meeting the second convertor

Messrs. H. B. Laine (C.E.A.), G. B. Jackson (C.E.A.), A. M. Morgan (Enfield Cables, Ltd.), H. Esther (N.E. Electricity Board), J. H. Dance (C.E.A.) and C. G. Richards (C.E.A.)

in each terminal station of the Sweden to Gotland underwater transmission (the first modern h.v. d.c. scheme in commercial operation) had been commissioned and the cable supplied most of the power consumed in the island. During water shortage, surplus power from the thermal station in Gotland had been fed back into the Swedish grid. Although there was no synchronous machinery near the mainland convertor station, service had been as good as in the normal direction of power flow.

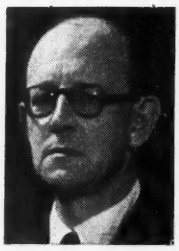
In the second paper comparative costs were submitted of the two types of transmission, which had been worked out afresh (Lane (C.E.A.) and Rathsman, Lamm and Smedsfelt (Sweden)). This inquiry took into account recent substantial developments, particularly in regard to convertors, which could now be built for considerably higher voltages than the 50 kV of the Gotland scheme. Comparisons were drawn on a basis of overhead lines of 300 to 1,000 km and of submarine cables of 30 to 100 km. In the first case a voltage of 400 kV a.c. was chosen for lines which when compensated by series capacitors would have a most economical loading of 750 MW. For d.c. having the same capacity, a two-pole line at ± 300 kV with mid-point at earth potential was taken. All costs were based on Swedish price levels in the spring of 1955, viz: rolled iron, £42/ton; aluminium wire billets, £173/ton; copper wire bars, £346/ton. Capital and operation costs in numerous circumstances were tabulated.

The chief conclusions reached were as follows. As d.c. was characterised by lower line and higher station costs than a.c., it became competitive only beyond transmission distances that depended on local circumstances. Cost curves for overhead transmission from a power plant to an a.c. distribution network indicated equality at 530 km for 1,500 MW and at 650 km for 750 MW transmission capacity. For submarine cables the cost curves intersected at 37 km for 750 MW capacity and at 30 km for 100 MW. Regulation of power flow could be effected independently of the frequency and voltage of the connected a.c. network.

Cables for d.c. could be expected to have a longer life than a.c. cables, which were more subject to dielectric fatigue and overcurrent stresses. Short-circuit stresses in the connected a.c. networks would be reduced with d.c. transmission. The relatively high cost of convertor stations made intermediate tappings of a long line less desirable than with a.c., while protection of telecommunication circuits against disturbances from harmonics might sometimes add to the cost of direct current schemes.

A report on single-piece porcelain insulators, having dimensions far exceeding those now used for overhead lines, was presented (Gillam, Taylor Tunnicliff Co.).

Mr. C. T. W. Sutton (Enfield Cables, Ltd.), Mr. W. Hutton (S. of Scotland E.B.), Mrs. Hutton, Mr. E. W. Connon (C.E.A.) and Mr. I. Glover (C.E.A.)



G. H. Gillam

E. W. Connon

S. J. Morley

Practices differed from country to country and there were as yet no national specifications. The rate of change of temperature involved in applying the I.E.C. cycle test had been demonstrated to exceed by many thousands of times that measured in service, but good insulators for overhead lines could withstand the 70 deg C change for five cycles. The same test might, however, overstress large insulators of the kind under discussion, which were known to be capable of withstanding all temperature changes to be found in practice.

A test method was described (Von Cron, Germany) which indicated the extent to which the value of flashover voltage of an insulator was influenced by the conductivity of foreign layers on its surface and by insulator shape. The flashover voltage depended on the width as well as the length of the leakage path and slender insulators were therefore preferable.

Generating Plant Studies

The report of the Generator Study Committee (Belfils, chairman) intimated that d.c. tests on windings caused less fatigue to the insulation than did a.c. tests. The d.c./a.c. test-voltage ratio of 1·6 to 1 usually taken should be checked. In most cases the winding required protection against fault current up to 90 or 95 per cent from the neutral point, as against 100 per cent for very large machines.

Measurements of temperature rises of alternators with a view to obtaining maximum loading, rather than as a safeguard against faulty operation, were reviewed (Connon and Morley, C.E.A.). Emphasis was laid on presenting the information available from seven specified instruments in a way readily appreciated by operating staffs. Recent improvements in alternator cooling in the U.S.A. (Ringland, Kilbourne & Kilgore) included the bringing of hydrogen into direct contact with the copper of both stators and rotors and, in some cases, the liquid cooling of stator coils. These methods had permitted the doubling of the rating of two-pole rotors and the building of machines of 320 MVA and upwards. For smaller ratings the advantages were savings in weight and size and lower short-circuit currents and torques. The maximum output obtainable with present hydrogen cooling at 30 lb/sq in was 225 MVA, owing to physical limitations of rotor diameter due to stresses and of rotor length due to flexibility and balance problems.

The water cooling of alternators, particularly when operating under difficult thermal conditions, had given valuable increases in output at small additional cost (Mandi, Urbanek and

Hellier, Hungary). The best and most economic method was to increase the cooling of the circulating air by feeding part of the existing cooling system with cooler water supplied by a steam ejector forming an organic part of the thermal system of the generating station.

The use of a portable stroboflash equipment incorporating a phase-shifting network as a precision instrument for measuring relative movement between rotor and stator fields under steady state conditions was described (Powell, C.E.A.). It was said to be of considerable assistance when diagnosing the causes of erratic load variations, since the relative movements of the rotor with respect to the stator field would determine whether the trouble was due to the alternator or the turbine. The stroboscope equipment in conjunction with a synchronised cine-camera provided a simple means of studying the behaviour of plant when operating under transient conditions.

Transmission Line Towers

In a discussion on transmission line towers, it was submitted (Paschoud) that the design of foundations (which might be of the block type or of the sleeper type for each footing) was the most urgent aspect. The present tendency was towards casting the foundations separately as being more economical, but the block construction had a wide field and provided the chief subject for discussion. The nature of the soil had little effect on block foundations in firm soils, excluding the extremes of rocks and dry sand dunes and of mud and peat, and there was no relation between it and amplitude of rotation of the foundation (Lazard, France).

A preliminary review (Simpson) was given of accelerated and slow tests put in hand by British Insulated Callender's Construction Co., for determining the relative resistance to overturning of side bearing concrete blocks. Although settlement of clays might take over a year, it was held that standard designs indiscriminately based on long-term testing would be unduly conservative, since high wind loads were seldom of long duration.

Test methods in Sweden were said to introduce a new characteristic—duration of application of the turning moment as a decisive factor in interpreting results of tests on block foundations in firm ground (Zetterholm). Fundamental importance was attached to tests to destruction, to which progress in design and fabrication of steel towers in Italy was mainly attributed (Castelbianco). In the recent construction of a 225 kV 275 km line in France, considerable economies had been effected by the use of 592 sq mm a.s.c.r. conductors (compared with the previous largest, 411 sq mm) and by the adoption of smaller electrical clearances which were found adequate under the wind conditions which were encountered (Masson, Lafont and Fayoux).

Circuit-Breakers

Under the heading of circuit-breakers, the committee chairman (Schiller, Switzerland) raised the question of what proportion of the total possible short-circuit power at any point could occur when busbars were fed solely by transformers and generators. British proposals regarding natural frequencies corresponded to approximately 100 per cent of this "locally generated short-circuit power" which was regarded by Continental engineers as too severe to provide an economic basis for a general specification. Mention was made of the advisability of standardising a second natural-frequency range to cover circuit-breakers up to 50 kV and 2,000 MVA, within which all the short-circuit power might be locally generated. The foregoing natural frequency values related to full breaking capacity. A similar series covering higher values and applying to a fraction of the rated capacity could later be discussed.

E. B. Powell

N. G. Simpson

A. M. Cassie

F. O. Mason

D. H. Edels

F. Crawford

Network analysers were said to have given too high values of amplitude factors for full short-circuit clearance and the French figure of 1·3 derived from field experience was considered to be well-chosen. No specification relating to over-voltages during interruption of small inductive currents was yet feasible, since the complex effects of a network configuration could not readily be analysed. It was suggested that the magnitude of overvoltages should be referred to the withstand voltage of insulation, instead of to the peak value of the power-frequency phase-to-neutral voltage; this would reduce dependence on individual network features, e.g. earthed or isolated neutral. Improved methods of measuring post-arc currents had revealed the need to correct some earlier results.

Post-arc currents in gas-blast circuit-breakers, as evidenced by the damping of restriking voltage beyond that of the circuit, were shown to depend upon gas-flow, that was, the axial pressure gradient in which the arc column was situated (Cassie and Mason, Electrical Research Association). Reignition of the arc after current zero was not always attributable to simple voltage breakdown of dielectric strength and, where post-arc conductance was present, the mechanism was due to some form of thermal or energy balance. Accurate records of conductance during the current-zero period had made possible analysis of the interaction of the types of loss from the column.

The arc near the current zero could be either a thin high-current arc, the diameter of which was decisive for reignition, or a diffused arc, in which case conditions for extinguishing were favourable, notwithstanding the possible presence of a post-arc current (Ter Horst and Rutgers, Netherlands). Related to the same subject was a description of a technique (Edels and Crawford, Liverpool University) by which accurate determination of free recovery of gaps after arc interruption could be obtained as time-dependent re-ignition voltage curves. Results in general were explainable by thermal considerations, but the existence of unique pauses in the recovery were believed to be determined by minimum spark breakdown.

Particulars were given of a new method of system operation by connecting a single circuit-breaker in parallel with each busbar instead of having multiple breakers for each

Mr. J. F. Stanley (B.S.I.), Mr. L. Ruppert (secretary, I.E.C.), Dr. J. S. Forrest (C.E.A.), Mr. Csuros (C.E.A.) and Mr. A. Chorlton (C.E.A.)

line connected in series (Cabanes and Dietsch, France). Tests were described for dealing with transient faults at 225 and 380 kV.

New designs and modified old designs of circuit-breakers were reported as keeping pace with increasing ratings of generators in the U.S.A. (Gaty). Generators up to 325 MW were now being built for stations of over 1,000 MW output. To-day 25,000 MVA breakers were a reality and those for 50,000 MVA (at which the practical upper limit of short-circuit current might be 70 kA) were on the horizon. A new type of circuit-breaker, designed to meet Canadian requirements economically, resembled a bulk-oil breaker physically but used compressed air as dielectric, interrupting means and operating medium. All linkages and other conventional mechanisms were dispensed with (Skillen and McKeough).

A theory to account for abrupt development of hot contacts with heavy oxidation of bolted busbar joints and switches that had been closed for some time was presented (Rieder, Austria). Contact dimensions should be such that surface temperatures never exceeded 100 deg C. The greater the contact force and the larger the surface, the later the consequences of oxidation would appear. Permanent joints should be roughened and oiled immediately before assembly. Opening and reclosing of a switch would usually be enough to defer contact ageing.

System Stability

The report of the study committee on system stability, compiled by Crary (U.S.A.), Rathsman (Sweden) and Robert (France), referred to an increasing use of transient analysers, further information on which was submitted in an appendix (Concordia, U.S.A.). Mention was made of two large a.c. analysers installed in Great Britain since the last C.I.G.R.E. meeting and of a micro-network, comprising six machines and three rotating bands, in the U.S.S.R. The prospect of standardising a simple means of accurate comparison between results of different network studies seemed poor (Herlitz, Sweden).

The number of conductors to form a " bundle " varied in different countries. Britain, Finland, France and Sweden had chosen double, U.S.S.R. triple and Germany quadruple formations. The use of series capacitors to increase transmission capacity was expanding. Operating experience over six years in Sweden at 130, 220 and 380 kV had been excellent (Jancke and Smedsfelt). On the 380 kV system transmission capacity had been raised from 400 to 650 MW with 40 per cent compensation, reducing total network losses by 6 to 7 MW.

The possibility of series capacitors proving more economical than synchronous condensers or shunt capacitors for line voltage regulation at 132, 220 and 275 kV was suggested (Black, South Africa). Results of tests on single-phase reclosing were summarised (Meyer, Switzerland); these related to a 100 km 220 kV line in Switzerland and a 220 km 400 kV line in Sweden. In the latter case reclosing was successful at 400 to 450 kV and with a dead time of 0·3 to 0·4 sec, indicating that residual current transmitted from the live conductors to the conductor disconnected was small enough to be extinguished.

Approximately 90 per cent of interconnected areas in the U.S.A. operated under automatic control, but only a few systems had 90 per cent of their generating capacity so controlled and only one reached 100 per cent. An accelerated utilisation of microwave installations and computers was a necessary adjunct (Morehouse, U.S.A.). Scale model tests for automatic frequency and load control of the West German interconnected system would be brought into use probably next year (Boll and Fleischer). A method of estimating, with the aid of a network analyser, the unbalance on a three-phase high-voltage system caused by the connection of single-phase loads, e.g. electric railways or large furnaces, showed that the " alpha, beta, zero " system of components gave the best solution (Daycard, Chile).

A further report of the conference proceedings will appear in next week's issue.

Letter to the Editor

Letters should bear the writers' names and addresses, not necessarily for publication. Responsibility cannot be accepted for the opinions expressed by correspondents.

Street Lighting

I FEEL that Mr. Whittaker, in his letter to you last week, cannot have made himself fully acquainted with the contents of the very excellent paper by Messrs. Ferguson and Stevens presented at the recent Summer Meeting of the Illuminating Engineering Society at Harrogate, otherwise he would have realised that conditions were identical for the comparative tests.

I think I am voicing the opinion of the majority when I say that from the users' point of view the chief disability of high-pressure mercury vapour lighting is the apparent greater glare. I say " apparent," because the preference for sodium remained under controlled conditions. It was because of this that I suggested during the discussion following the paper that the reason may be found in the field of psychology, and that the blue-green light of mercury vapour is more of an irritant than the yellow emitted by a sodium lamp.

The whole subject is, I think, very controversial, since we are treading on ground without defined pathways in the way of definite formulæ. It is very much to be hoped that further investigations will be undertaken—might I suggest with the co-operation of the ophthalmic profession?

Cardiff.

F. H. PULVERMACHER, A.M.I.E.E.,
Illumination Engineer,
South Wales Electricity Board.

INDUSTRIAL NEWS

Ironmongers and Electrical Discounts

Mr. Lewis Hall, chairman of the Electrical Section of the National Federation of Ironmongers, reported at the annual conference at Scarborough on 28th May that with electrical lines there was far more "come back" risk than with household goods and more technical ability was required to handle them.

If the manufacturers felt that 25 per cent and sometimes more was a reasonable discount for electrical contractors who carried no stock risk whatever, then should not the electrical ironmonger who carried large stocks, and also had a contractor's side to his business, be given at least 33⅓ per cent or to be more realistic still, 30 per cent and 10 per cent? "Looking back through the years, experience has proved that we cannot expect to get much help in our fight for better discounts from other electrical associations. . . . In any case our business principles are totally at variance with one strong association for instance, who in the main, are composed of shopless traders enjoying the same discount as ourselves."

Another vital problem with which those in the Electrical Section would have to concern themselves was what might be termed the enlightening of the Monopolies Commission and the Civil Service in general about alleged restrictive practices. Ironmongers knew that odd cases of price fixing which some purely local associations had had in the past, had always been for the good of the trade and of the public in particular. Practices which had been built up painfully through the years, by trial and error, were not lightly to be given up because some "jumped-up jack in office" suggested that they were not in the public interest, and hoped to make political capital out of them.

E.I.B.A. Annual Meeting

The annual general meeting of the Electrical Industries Benevolent Association will be held on Thursday, 12th July (11.30 a.m.) at the Cable Makers' Association, High Holborn House, 52-54, High Holborn, London, W.C.1.

Automation and Industry

Automation and its impact on industry was discussed at the National Cost Conference of the Institute of Cost and Works Accountants at Edinburgh on 1st June. In his presidential address, Mr. G. Nicholson, F.C.W.A., warned industry not to assume that a new industrial revolution through automation was the answer to the problems of productivity and exports. There has been a great deal of comment, some creating widespread consternation and other seeming to promise an even lazier life for industry with talk, not of more production, but of shorter working days and a shorter working week. If this latter view prevailed it could hardly be, in the short run, a cure for our present problems. Intelligently used, the latest developments in automatic machinery would increase the productive resources of this country. The two papers presented to the conference also dealt with automation from different aspects. The papers were: "The Impact of Automation on Management Accounting" by Mr. D. J. Young, secretary and comptroller, the Steel Company of Wales, Ltd., and "Looking Forward" by Mr. R. W. Duffield (Molins Machine Co., Ltd.).

Export of Aluminium Goods

The Board of Trade has issued a statement announcing that the export of aluminium scrap is prohibited. In order to ensure that aluminium scrap metal is retained in the United Kingdom, the export of certain aluminium and aluminium alloy goods to any destination will be subject to licence as from 11th June. The relevant Amendment Order is the Export of Goods (Control) (Amendment No. 6) Order, 1956 (S.I. 1956/789).

The Board of Trade also announces the issue of an open general licence which authorises the export of certain goods of aluminium or aluminium alloy valued at more than £240 per ton. The licence, which does not apply to exports to China, Macao, North Viet Nam or Tibet, also comes into operation on 11th June.

Key Industry Duty Exemptions

The Board of Trade is considering the question of the renewal for the period 19th August, 1956, to 18th February, 1957, of the exemptions from Key Industry Duty as set out in the Safeguarding of Industries Exemption Orders Nos. 2, 3 and 5, 1956, and in any further Exemption Orders which may be made before 19th August, under Section 10 (5) of the Finance Act, 1926, as amended by subsequent enactments. Lists of the articles exempted from Key Industry Duty by these Orders until 18th August, 1956, were published as Statutory Instruments, 1956, Nos. 169, 486 and 717. Any communications regarding this announcement should be addressed to Tariff Division, Board of Trade, Horse Guards Avenue, London, S.W.1, by 16th June.

Welding Conference

A conference on the functions and education of welding engineers, organised by the Institute of Welding, will be held from 16th to 18th September at Ashorne Hill, near Leamington Spa. The closing date for enrolment is 3rd August, and enrolment forms can be obtained from the Institute at 2, Buckingham Palace Gardens, Buckingham Palace Road, London, S.W.1.

Fluorescent Lamp Price Reduction

The Electric Lamp Manufacturers' Association announces that the list price of 8ft 125 W fluorescent lamps MCFA/U and MCFC/U in daylight, natural and warm-white marketed by its members has been reduced from 32s 6d to 25s.

Similar announcements have been made by Philips Electrical, Ltd., and Thorn Electrical Industries, Ltd.

Equipment in New Tanker

Complete electrical equipment for the engine room of the new 18,000 ton tanker *Hygromia* has been supplied by the General Electric Co., Ltd. The ship has been built at Glasgow by Lithgows, Ltd., for Shell Tankers, Ltd. Electric power is supplied by two G.E.C. 550 kW 440 V three-phase 60 c/s turbo-alternators. For emergency and port use the ship is equipped with a 200 kW 600 r.p.m. alternator driven by a British Polar diesel engine. The G.E.C. has supplied, also, the main, port and starboard group starter switchboards.

Among the thirty motors of various types with which the ship is equipped are three 56 h.p. main

The stand of the South Western Electricity Board at the Bath and West Show, Cardiff, on which was displayed a wide range of agricultural and domestic electrical equipment

circulating pump motors; two 31 h.p. auxiliary circulating pump motors; two 38/16 h.p. forced draught fan motors; and two 20 h.p. steering gear motors.

The ship is equipped with a 178 h.p. feed pump motor having an auto-transformer starter with a mechanical time delay which controls the change-over from the starting tapping to the line connection. The complete galley equipment, also supplied by the G.E.C., includes a three-oven range, a double deck baking oven, a proving cupboard, a steaming oven, a griller, water boilers and pantry hotcupboards.

Generating Plant for Hong Kong

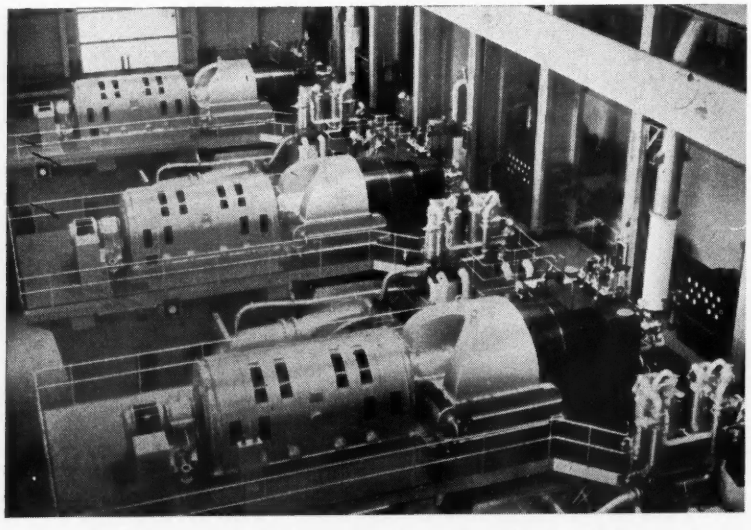
Two further steam turbo-generator sets, each rated at 30 MW, have been ordered from the Metropolitan-Vickers Electrical Co., Ltd., by the China Light & Power Co. They will be installed in the Hok Un generating station on the mainland of Hong Kong. The contract, which is worth nearly £700,000, includes the associated condensing, feed heating, and evaporating plant and follows a previous order for a similar generating set, which is due for despatch next year. The new sets, which are to be delivered during 1958, are the seventh and eighth to be supplied by the company; four 20 MW and one 12·5 MW machines are at present in operation, three of the former being seen in the accompanying illustration.

The new turbines are to be 30 MW (m.c.r.) two-cylinder machines running at 3,000 r.p.m. with steam at 600 lb/sq in, 850 deg F. The final feed water temperature at 24 MW (e.c.r.) is 330 deg F, and each turbine exhausts to a twin-shell central-flow condenser at a vacuum of 27·86in Hg. The h.p. cylinder has twenty-three stages, and the double flow l.p. cylinder six stages. The h.p. cylinder casing is of cast steel, except for the exhaust end which, like the l.p. casing, is of cast iron. Stainless steel is used for the moving blades, and ½ per cent molybdenum steel and stainless steel for the fixed blading. The rotors are connected by a Bibby type coupling.

The generators are rated at 37·5 MVA and generate three-phase 50 c/s a.c. at 11·8 kV. They are air-cooled machines with a closed circuit ventilation system, the coolers being mounted in the foundations below the machine. Ventilation is on the M-V combined radial and axial system; the air is circulated round the system by two fans mounted one at each end of the rotor. Excitation is provided from a direct-connected main exciter, which is separately excited from a constant-voltage pilot exciter. Voltage control is by an automatic voltage regulator, type VSA. In addition to the new turbine-generators, the Metropolitan-Vickers Co. is to supply (through International Combustion, Ltd.) six two-speed squirrel cage motors, type RS, for driving induced draught and forced draught fans on the boilers. Three of these motors are of 187/94 h.p. and three of 452/235 h.p. M-V motors were also used on the earlier boiler auxiliary drives at Hok Un.

"Motor Transport" Cost Tables

The latest costs of running all types of goods vehicles, including variations in drivers' wages and the cost of petrol and diesel fuel are given in "*Motor Transport* Cost Tables" published by Iliffe & Sons, Ltd., Dorset House, Stamford Street, London, S.E.1 (price 1s, postage 2d). The tables show the standing costs per year, per week and per hour; the running costs per mile; and the total charge per mile over a range of annual mileages for each size of vehicle, according to the part of the country in which it is based. Also included in the booklet is the *Motor Transport* fuel cost ready reckoner which gives the cost of fuel in pence per mile for all rates of consumption between 5 m.p.g. and 30 m.p.g. and for all prices of fuel from 3s 6d to 4s 9d in ¼d steps.



Three 20 MW Metropolitan-Vickers turbo-generator sets in the Hok Un power station of the China Light & Power Co., Hong Kong

Plant for Malayan Power Station

An order has been received by the English Electric Co., Ltd., from the Crown Agents for Overseas Governments to supply and erect two 10,000 kW steam turbo-alternator sets for the Malayan Central Electricity Board. The value of this export order is approximately £350,000. These two sets will be installed in a new generating station which is to be built at Malacca on the West Coast of Malaya. Power generated at the station will feed into the southern end of the Central Malayan electricity grid. The consulting engineers for this project are Preece, Cardew & Rider and the equipment will be designed and manufactured at the English Electric Co.'s works at Stafford and Rugby.

Optical Instruments for Germany

Aldis Brothers, Ltd., Birmingham, have secured an order from Germany for 1,000 "Aldisettes," a new addition to this company's range of visual aid equipment. The "Aldisette" establishes a new standard for small a.c./d.c. still projectors for colour transparencies.

Works Visit

Mr. R. Maudling, M.P., Minister of Supply, visited the Plessey Co., Ltd., Ilford, on 28th May for discussions with the chairman, Mr. A. G. Clark, and directors of the company. He was accompanied by the two Members of Parliament for the Ilford area, S/Ldr. A. E. Cooper (Ilford South) and Mr. T. Iremonger (Ilford North). During his visit he saw the recent advances made by the group in the fields of electronics, aircraft engineering, nucleonics and automation.

I.T.A. Emley Moor Transmissions

The transmission of low power test signals will begin in July from the site of the Independent Television Authority's second Northern transmitter at Emley Moor, Yorkshire. These low power signals will be put out from the mobile transmitter which was originally designed, built and operated by Belling & Lee, Ltd. As on previous occasions, the transmitter will operate at an effective radiated power of 1 kW and with an aerial height of approximately 90ft.

Senior Buyers' Course

The Purchasing Officers Association is holding a senior buyers' course at Ashorne Hill, near Leamington Spa, from 7th to 11th November next. The course is intended to give senior buyers in industrial and public undertakings the opportunity of studying the various aspects of their function, in company with others of similar experience drawn from as wide a

cross-section of industry as possible. The number on the course will be limited to fifty, but further courses will be arranged periodically. The course leader will be Mr. J. Ferguson, Chloride Batteries, Ltd., and chairman of the Association's Education Committee. The fee of 15 guineas will include accommodation and all meals, and applications, on forms which may be obtained from the Association, Wardrobe Court, 146a, Queen Victoria Street, London, E.C.4, should be made by 1st September.

Atomic Power in Mexico

Mr. B. Nikiforoff, technical director of the Mexican Light & Power Co., referred recently to the steps being taken in Mexico to provide staff qualified to construct and operate atomic reactors. Following a visit to the country last year of Dean E. Blythe Stason, of Michigan University and managing director of the Fund for Peaceful Atomic Development, he said, five young Mexican engineers were now studying atomic energy applications at Michigan University.

In Mexico itself, as part of the slowly developing programme of setting up a pool of qualified personnel, more than 130 of the power company's engineers are studying the principles of atomic power on a voluntary basis. An Atomic Energy Group, which meets twice a month, has been formed and a library of atomic literature is being gathered together.

Uranium from Canada

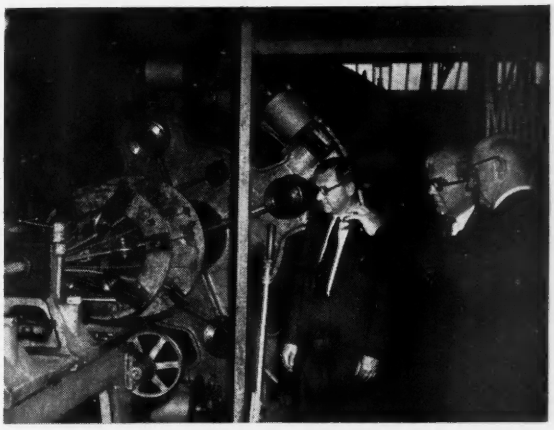
The United Kingdom Atomic Energy Authority has, with the consent of the Government of Canada, entered into negotiation with Eldorado Mining & Refining, Ltd., for the delivery of a substantial quantity of uranium before 31st March, 1962. This will represent a major contribution to the supplies of uranium required to meet programmes for which the Authority is responsible. Detailed contract arrangements between the Authority, Eldorado Mining & Refining, Ltd., and the individual Canadian mines will be similar to those under which uranium has been supplied to the United States Atomic Energy Commission.

Copying Documents

The Minnesota Mining & Manufacturing Co., Ltd., recently demonstrated a new document copying machine called "The Secretary." This produces copies of almost any item in four seconds or less, without inks, stencils or any kind of preparation or processing. The item to be copied is placed beneath a quarto or foolscap sheet of specially treated air-mail weight paper, fed into an aperture on to a moving belt and retrieved from a lower aperture seconds later.

"The Secretary" copying machine

The special paper employed is sensitive to heat and as the original copy and the treated paper enter the machine a high-power infra-red lamp is switched on. The non-image or unprinted area of the original reflects the light while the written, printed or typed copy absorbs the light and causes a reaction on the special copying paper. The result is that where there is a mark on the original an identical mark is reproduced on the copying paper. Heat is removed from the machine in operation by two small fans and the original and the copy are driven round on a plastic belt by a small motor, operation being from the normal mains supply.



Dr. Charles Hill, Postmaster-General (centre) with Sir Thomas Spencer (right), chairman and managing director of Standard Telephones & Cables, Ltd., and Mr. G. H. Bairstow (left), works manager, inspecting a cable laying-up machine at the company's North Woolwich works

Annual Holidays

The works of Holophane, Ltd., at Elverton Street, Westminster, London, S.W.1, will be closed for the annual holiday from 16th to 30th June inclusive. The offices will not close, but during the period no deliveries will be made.

High-Frequency Hand Tools

To bring home to manufacturers the advantages of using high-frequency tools as opposed to the universal electrical or pneumatic tool, Burton, Griffiths & Co., Ltd., of Sparkbrook, Birmingham, 11, have made arrangements with Robert Bosch A.G., of Germany, for their mobile demonstration and servicing unit to tour various areas in Britain. They claim that using the Bosch 2 kVA convertor, even small units of one or two tools pay for their keep due to the very low maintenance costs and, where grinders are concerned, great saving in wheel life. In addition, when employing high-frequency tools, speed drop is lower.

P.M.G. at Cable Works

The Postmaster-General, Dr. Charles Hill, accompanied by Sir Thomas Spencer, chairman and managing director of Standard Telephones & Cables, Ltd., recently visited the North Woolwich works of the company where he saw cables and telecommunication equipment being manufactured for the British Post Office and for overseas administrations.

Refrigerator Survey

In our survey of domestic electric refrigerators (*Electrical Review*, 11th May) the prices of the Lec Refrigeration, Ltd., models were incorrectly given. They should read as follows:—P.42—£48 9s plus £22 13s 6d purchase tax; P.62—£62 3s 2d plus £29 1s 10d purchase tax; P.6—£66 10s plus £31 2s 5d purchase tax; and P.9—£80 plus £37 8s 10d purchase tax.

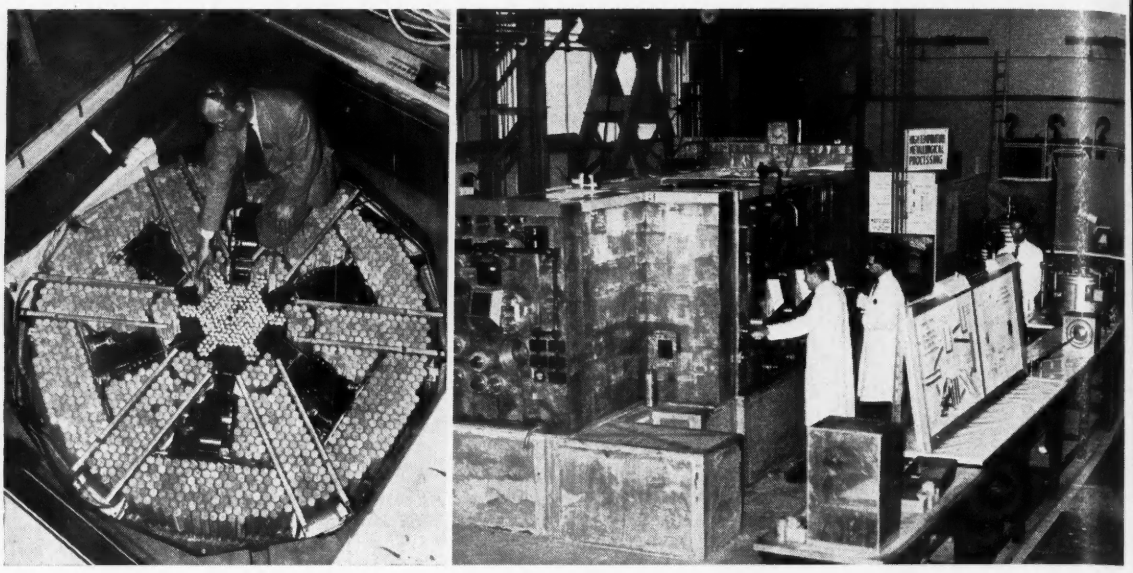
Trade Announcements

Hallam, Sleigh & Cheston, Ltd., have moved their technical sales office to Oldfield Road, Maidenhead (telephone: Maidenhead 4311).

As from 22nd June the divisional offices of **Hilger & Watts, Ltd.,** at 48, Addington Square, London, S.E.5, will be closed and the sales and administrative departments of the company will be combined at Camden Town. From 25th June the address will be 98, St. Pancras Way, Camden Road, London, N.W.1 (telephone: Gulliver 5636). The Camberwell factory will remain, together with certain technical departments, at 123, Camberwell Road, London, S.E.5.

The Marley Tile Co., Ltd., has acquired the whole of the capital of Wallington Weston & Co., Ltd., Frome. There will be no major changes in management or in the plastic and synthetic rubber products of the company, which include electrical, engineering and aircraft equipment.

The Birmingham Branch Office of **Midland Silicones, Ltd.,** is now at Union Chambers, 63, Temple Row, Birmingham, 2 (telephone: Midland 7705).



Left: Here Dr. R. D. Smith is pointing to the enriched uranium core of a fast reactor at Harwell. Around the outside of the core can be seen the tops of the natural uranium blanket elements which will be converted into plutonium during working. Right: This equipment is employed for the high temperature metallurgical processing of reactor fuel

Atomic Research at Harwell

FIRST SERIES OF "OPEN DAYS" HELD LAST WEEK

THE work of the Harwell Atomic Energy Research Establishment covers a very wide field and last week a series of "open days" was held for the first time to enable interested visitors to learn something of the work which is being done. The recent changes in the security classification of atomic energy research products enabled the establishment to show exhibits covering most of its work and achievements over the first ten years of its operation.

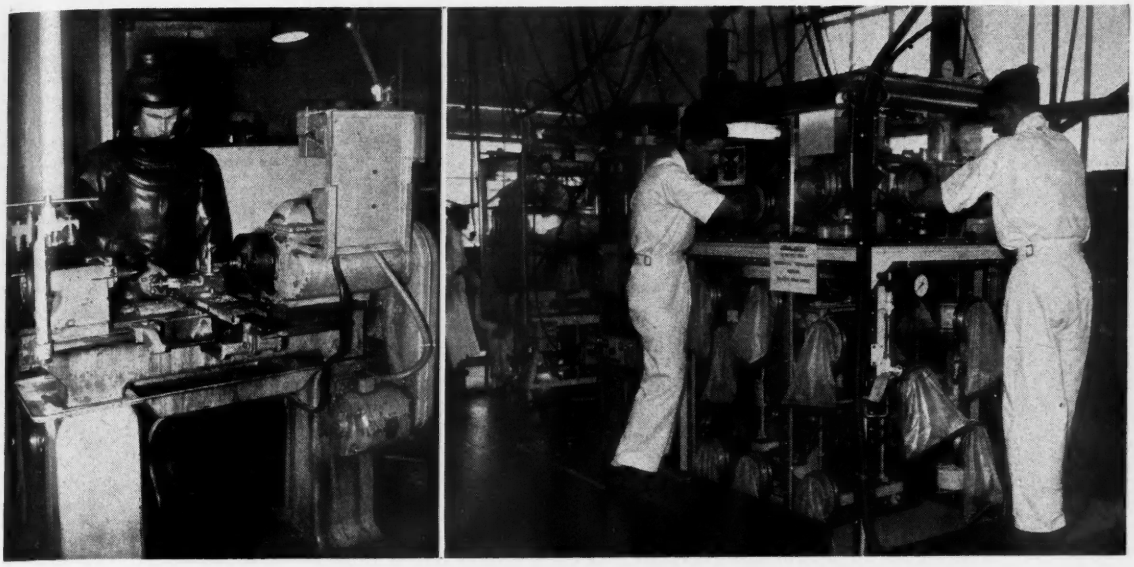
Harwell is responsible for the early work and basic science and technology primarily directed towards the civilian aspects of atomic energy, although some assistance is given to the Weapons Groups on specific problems. For two years work has been in progress on the technology and feasibility study of the gas-cooled graphite-moderated reactor which is now being built at Calder Hall (see *Electrical Review*, 25th November, 1955). Thus the Establishment is now involved in a fair amount of work helping industry in the development and design of improved power stations of this type which are to be built in Stage I of the power programme of the Central Electricity Authority. These power stations will be a great improvement on Calder Hall; they will be economic and will be built in successively improved versions throughout the 1960s.

Work is already being done at Harwell and in the Industrial Group of the Atomic Energy Authority on nuclear power stations for the second stage of the programme, when it is expected to have plutonium available from Stage I to enrich the uranium fuel of the reactors. Two competitors for this stage are at present being investigated. The first is a reactor using water to surround the uranium rods and transfer the heat, while the second uses graphite as a moderator but employs liquid sodium to transfer the heat instead of gas.

These reactors raise many technical problems requiring development work, particularly due to the corrosion of the reactor materials. Their main advantage over the gas-cooled reactor is that they would have a lower initial uranium investment and possibly slightly lower capital costs. The Atomic Energy Authority expects to build a prototype of the selected reactor by 1960 and if it proves to be attractive from the economic standpoint the gas-cooled reactor stations might be replaced in the late 1960s.

Active work is also being done at Harwell on reactors whose potential large-scale application is still further off in time: the 1970s. The objective here is to achieve breeding to reduce the amount of uranium required to develop power by a factor of about 100. The fast reactor of the type under construction at Dounreay in the North of Scotland is the first of these. At Harwell two precursors, "ZEPHYR" and "ZEUS," have been built to study the breeding capabilities and nuclear properties of fast reactors using plutonium and U235 as fuel. When we were at Harwell last week we saw "ZEUS," which is a fast reactor with an enriched uranium core and is a low energy version of the 60 MW fast reactor being built at Dounreay. It is run at a power of less than 100 W and therefore needs no provision for cooling the core, the sodium coolant used in the Dounreay reactor being replaced by aluminium and magnesium castings. Measurements on "ZEUS" provide design and operation data and basic information on the physics of this type of reactor.

A number of other advanced reactor systems are also being studied. Amongst these is the aqueous homogeneous reactor which uses a fuel of enriched uranyl sulphate dissolved in heavy water. Advantages are the elimination of costly fabrication and canning procedures and the possibility of continuous chemical processing to remove fission



Left: This mechanic is wearing a protective frogman's suit to work on a plutonium contaminated lathe. Right: Plutonium, artificially produced by irradiation of natural uranium, is drilled and weighed in this plutonium glove box

product neutron poisons. The reactor core is surrounded by a heavy water thorium dioxide slurry which produces U233. The uranium is separated and fed into the core system to replace that lost by fission.

To carry through the programme of development on these reactors requires an extensive range of testing facilities. The eight-year-old " BEPO " reactor is used now for at least 50 experiments. The maximum thermal neutron flux available is $1{\cdot}5 \times 10^{12}$n/sq cm/sec at a reactor power of 6·5 MW. It provides facilities for pile neutron research, radioactive isotope production, irradiation chemistry and metallurgy and reactor engineering research. The reactor consists of a graphite cube of 26ft side surrounded by thermal and biological shields. The 40 tons of uranium fuel is in rod form and lies in horizontal cooling channels in the graphite cube. Horizontal and vertical experimental hole facilities are provided, of which about 60 are in use.

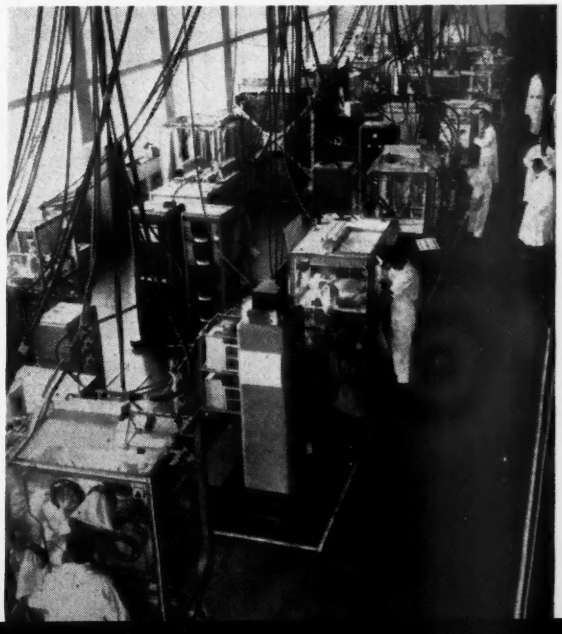
Three more reactors, " DIDO," " PLUTO " and " LIDO " are in course of construction. " DIDO," which is almost completed and should be in operation in about two months' time, will be used as a materials testing reactor. It is heavy water cooled and moderated, and utilises highly enriched uranium, alloyed with aluminium, as fuel. It is housed in a sealed cylindrical building. With its high intensity neutron flux of 10^{14}n/sq cm/sec at a designed heat output of 10 MW, the reactor's main purpose will be the irradiation of materials to be used in future reactors. Radiation damage particularly can be studied. High specific activity isotopes for medical and industrial use will be produced and facilities will be available for research in neutron physics and radiation chemistry.

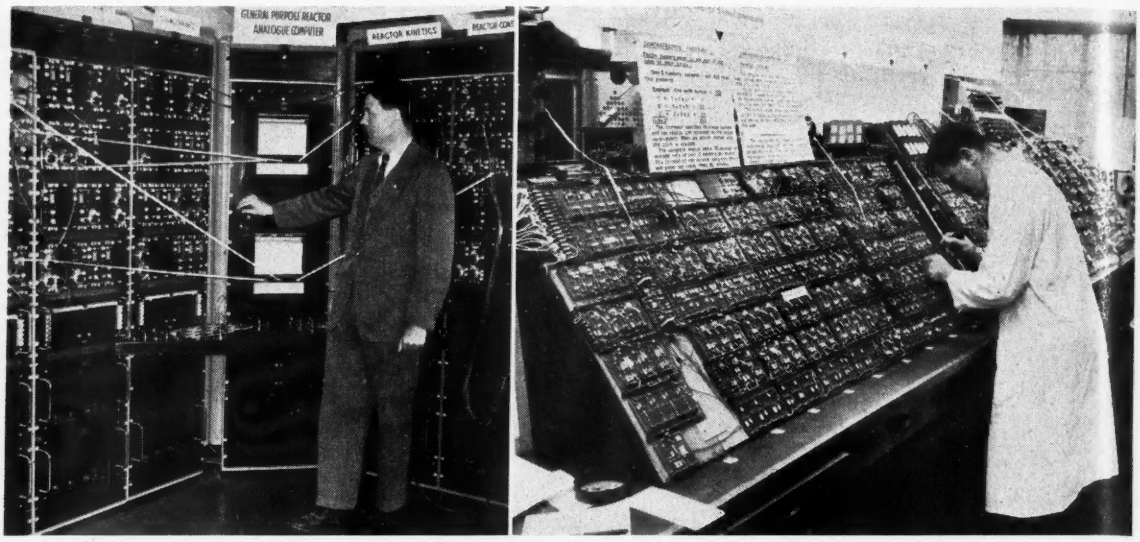
The completion of " PLUTO " is planned for mid-1957 and it will be used as a materials testing reactor of a more specialised type than " DIDO." It is cooled and moderated in the same way as " DIDO " and it uses the same fuel to provide the same output and, like " DIDO," it is housed in a sealed cylindrical building. Future reactor fuel elements will be irradiated under conditions closely representing their environment. By this method it will be possible to check heat transfer, corrosion, mass transfer, radiation decomposition and fluid fuel chemistry.

By September this year " LIDO " should be in operation. It is an enriched uranium solid fuel, demineralised light water moderated, reflected and cooled, thermal reactor giving 100 kW and 10^{12}n/sq cm/sec. It is of the " swimming pool " type and is primarily intended for shielding studies. A Portland concrete tank contains demineralised water which is pumped through a filter and cooler. A movable trolley with control platform has a submerged framework housing plate-type, natural convection cooled, fuel elements. Cadmium bearing rods driven within certain fuel elements control the reactor. Larger aluminium panels in the tank provide areas for testing shielding. Biological shielding is provided horizontally by the concrete tank and vertically by the water.

Harwell is expanding its facilities for developing the application of radio isotopes to industry and considers this to be of great promise. The Medical and Health Physics Divisions are responsible for the health of the staff and

In the chemical engineering laboratory processes suitable for industrial use are studied on a small scale





Left: This general purpose analogue computer is used for reactor design studies. Right: This transistor digital computer has a storage capacity of 500,000 binary digits and can be used for an almost unlimited range of tasks

also for scientific aspects of public health problems arising from atomic energy operations. Another aspect of the work involves a study of the nature and intensity of the radiation resulting from fall-out from nuclear weapons. This information is being transmitted to the Medical Research Council Committee on the Hazards of Nuclear Radiation.

In the Chemical Engineering Division an important part of the work is concerned with reactor fuel processing. This is required to repair irradiation damage and to remove fission products which have absorbed neutrons. The cost of processing is a substantial proportion of the cost of nuclear power and the work is aimed at reducing this cost. In existing processes the irradiated fuel element is dissolved in acid, the fission products are removed by solvent extraction and the fuel element is refabricated.

To avoid the expensive " metal-solution-metal " stages, high temperature metallurgical processes are being developed in which the fuel is kept in the metallic state and melting, slagging and vaporising techniques are used to remove neutron absorbers. Fuel element fabrication is still required. Work on the processing problems involved in the homogeneous aqueous reactor system is also conducted in this division. In this system, solid fuel elements are replaced by using a liquid fuel and consequently the limitation of physical breakdown under irradiation is removed and the expensive fuel element fabrication stage is avoided.

In the Metallurgy Division we saw two high frequency furnaces and an argon arc furnace used for preparing uranium, thorium and zirconium alloys. The argon arc furnace is fitted with a rotatable multi-impression hearth. The metallurgy of plutonium is of increasing importance to the nuclear power programme, since this metal will form a relatively large part of the supplies of fissile material available for fuel power reactors. Plutonium, which is artificially produced by irradiation of natural uranium, has to be handled by special glove-box techniques, since it presents an extreme toxicity hazard.

In the Electronics Division there is a transistor digital computer known as the " CADET." It has 320 transistors and no thermionic valves, and has a power consumption of only 70 W. Numbers and instructions are fed into the computer on punched cards and are stored on a magnetic drum with a capacity of more than 500,000 binary digits. The computer can be used for an almost unlimited range of tasks, provided they require only the basic operations of addition and subtraction.

There is also a reactor simulator in the Electronics Division which simulates the dynamic behaviour of a small experimental reactor when the shut-off and control rods are moved. The " reactor " can be started up by withdrawing the shut-off and control rods, the apparent rise in power level being traced out on a logarithmic scale recorder. Steady power level control or controlled shut-down is possible and automatic shut-down takes place if the rate of rise of the power level or the absolute power level is permitted to exceed certain pre-set values.

In addition to the technological work of the Establishment, about 20 per cent of the staff work on fundamental research tools such as the cyclotron and linear accelerator, as well as facilities for work in radiochemistry, solid state physics, and theoretical physics. As part of the long-term programme work is also being done on controlled thermo-nuclear reactions. This combines the field of high temperature physics with the nuclear physics of light elements. This project, although of great scientific interest, is as yet far away from practical application.

Conference of Standards Officers

NEARLY 120 engineers and others whose job it is to apply standards on the factory floor met in London recently for the second annual conference of standards officers arranged jointly by the British Standards Institution and the Institution of Production Engineers.

Among the interesting side issues was a suggestion from B.S.I. that training courses for standards officers might be established; the views of industry are to be sought.

Though there was much commendation of the standards published by the B.S.I. there was also some criticism. A delegate from the iron and steel industry, for example, complained of the great number of existing steel standards. An assurance came from Mr. G. Weston, B.S.I.'s technical director, that the Institution was now trying to secure a measure of simplification by reducing the number of standards for both steel and non-ferrous metals. A representative of a chemical firm wanted more standards, not for the end-products, but for the raw materials.

News from India

FROM OUR INDIAN CORRESPONDENT

THE end of March saw the conclusion of the first five-year plan during which, according to the report of the Ministry of Irrigation and Power, Rs.594 crores* was invested in power and irrigation schemes all over the country. Mr. G. L. Nanda, the Minister concerned, also reported to Parliament that plans are being made for speeding up the work of surveying the hydro-electric potential in India which some time ago had been assessed at about 35 million kW, but is probably nearer 50 million. He hinted that it might be possible to generate atomic power during the next five-year period, but gave the usual warning that hydro and thermal power would continue to be much cheaper for a long time to come.

It has been decided to set up a national construction corporation with a view to undertaking the construction of some of the bigger power projects whose general progress has been criticised both in and out of Parliament as rather unsatisfactory and old-fashioned. This corporation will be a State-financed and State-managed body and will work in conjunction with labour co-operatives, leaving out private contractors. The inspiration for this departure from the usual construction methods comes from China where it is customary for villagers in large numbers to be associated with a project in their district through the village bodies or their labour unions. It also conforms to the Government's industrial policy statement, viz. the gradual creation of a socialist pattern of society.

Mr. Nanda's report coincided with that of the Central Water and Power Commission on the public supply undertakings during 1954. There are now 682 undertakings in India of which 434 obtain power from their own generating plant and the rest merely carry out retail distribution of power purchased in bulk from other undertakings. Many of the private undertakings are being gradually acquired by the State and about a dozen were taken over in 1954. Of the 33 new undertakings which started functioning in that year, 27 were public and only six private. The tendency, therefore, is for the State to have an increasing share in the ownership and management of generating plants and distribution enterprises. Most of the undertakings taken over so far are small and medium sized and the only factor which has prevented bigger ones from being purchased is that of finance necessary for compensation, which in some cases runs as high as Rs.20 to 30 crores.

According to the report of the Central Water and Power Commission, the total generating capacity of public supply undertakings in India at the end of 1954 was 2,494 MW, of which 1,491 MW consisted of steam plant, 793 MW of hydro plant and 210 MW of diesel plant. Since a rough estimate of the total hydro-electric potential puts it at about 40 million kW, the above figures indicate that only about 2 per cent of this potential has so far been exploited. The increase over the previous year is 8·2 per cent. The increase in electricity production has been about 12·3 per cent from 6,697 million kWh in 1953 to 7,522 million in 1954; of the latter 54 per cent was generated by steam plant, 43 per cent by hydro plant and 3 per cent by diesel plant. It is interesting to note that though the steam power plant capacity increased by 7 per cent the corresponding energy increase was 13·6 per cent. In the case of hydro plant the capacity increased by 8·5 per cent but the energy increase was only 11·1 per cent. The hydro supply in India is to a large extent dependent on the regularity or otherwise of the monsoons and reports about rationing of water in the Madras reservoirs have appeared two months before the advent of the rains.

	1952	1953	1954
Plant capacity (MW)			
Steam	1,176	1,409	1,491
Hydro	715	731	793
Diesel	170	180	210
TOTAL ...	2,061	2,320	2,494
Output (million kWh)			
Steam	3,102	3,572	4,057
Hydro	2,799	2,913	3,236
Diesel	218	210	227
TOTAL ...	6,119	6,695	7,520

Note: The electricity production for 1955 has averaged about 700 million kWh per month as compared with about 600 million kWh for 1954.

Twenty-nine undertakings with an aggregate capacity of 2,165 MW (about 87 per cent of the total) in 1954 produced 92 per cent of the total electricity generated. The *per capita* consumption in each State varied from as low as 0·57 to 96·44 kWh. The average national *per capita* consumption was 17·38 kWh and production 20·88 kWh. Total capital expenditure amounted to about Rs.300 crores and the average revenue per kWh sold for all purposes was estimated at 1·073 annas (1·207d). The accompanying table summarises the electricity supply position in the three years 1952-54.

* Rs.1 crore = £750,000.

Europe's Future Energy Needs

THE Organisation for European Economic Co-operation (O.E.E.C.) published this week a report by its Commission for Energy set up on 10th June, 1955, under the chairmanship of Sir Harold Hartley, president of the World Power Conference. The report, which is entitled "Europe's Growing Needs of Energy—How Can They be Met?" says that consumption of all forms of energy in Europe, which in 1955 was equivalent to 730 million tons of coal, is rising so rapidly that in 1975 it is likely to reach a figure equivalent to 1,200 million tons of coal.

The Commission considered what part of the total requirements could be covered in 1975 by the production of primary energy in Western Europe, on the basis of present plans, and found this share to amount to about 750 million tons coal equivalent, excluding nuclear energy developments, as against about 580 million tons coal equivalent in 1955. The report emphasises that it would be quite erroneous to believe that nuclear energy would make large contributions to the supply of energy in Western Europe in the next twenty years, as it estimates that this contribution will not exceed a figure of 80 million tons coal equivalent by 1975, i.e. less than 8 per cent of total requirements. Unless a special effort is made to promote the indigenous production of primary energy, the remaining gap would have to be bridged by imports of coal and oil, the cost of which would amount in 1975 to about $5,000 million at present prices.

Coal will be the mainstay of the energy economy in Western Europe for many years to come and the increased output of coal will depend on long-term investment, improved mining methods and adequate terms of miners' pay.

WORLD ELECTRICAL MARKETS

Finland's Foreign Electrical Trade

By R. E. KAAN, Dipl.Ing.

ALTHOUGH she emerged from the war defeated, impoverished and economically exhausted, Finland has made a remarkable recovery since 1945. Under the peace treaty with the Soviet Union, she lost some of her most valuable assets, the greater part of Carelia, including some of the best forests, apart from agricultural land, nickel mines, and about one-tenth of the country's industrial resources.

Finland is not a member of the O.E.E.C., nor has she had the advantage of Marshall Aid, nevertheless she has discharged all her war liabilities and has gone a long way towards restoring her economic life. The reparation programme imposed by the Soviet Union was finished by the end of 1952, and the settlement of some 400,000 refugees from territories ceded to Russia was completed. This recovery was not achieved without cost; the price, apart from self-denial of her people, has been inflation with all its after-effects such as the steady fall of money values, rising costs, wages and taxes.

TABLE 1.—FINLAND'S ELECTRICAL IMPORTS BY COUNTRY (£000)

Country of Origin	1953	1954	Jan.-Sept., 1955
United Kingdom	929	1,367	1,324
Soviet Russia	136	290	144
United States	250	292	411
Western Germany	2,021	2,934	2,623

TABLE 2.—UNITED KINGDOM ELECTRICAL AND ALLIED EXPORTS TO FINLAND (£000)

Products	1953	1954	Jan.-Sept., 1955
Generating plant	22·5	71·2	15·2
Steam and water turbines	8·1	10·4	20·9
Steam condensers	0·2	1·0	—
Motors	57·2	84·7	62·2
Control gear	45·2	20·9	9·1
Transformers	100·7	87·0	124·0
Switchgear	42·0	70·0	89·0
Convertors	1·1	14·0	21·0
Rectifiers	1·0	1·1	3·5
Welding plant and electrodes ...	14·1	44·8	26·1
Refrigerators	43·2	27·6	89·7
Cookers and heating appliances ...	13·2	30·3	17·5
Vacuum cleaners and parts	57·9	30·4	194·0
Floor polishers	13·6	16·7	26·8
Washing machines	59·7	10·3	14·4
Other domestic appliances	12·7	27·4	9·1
Instruments and meters	24·7	56·4	41·6
Electro-medical and X-ray apparatus	13·1	10·1	6·9

TABLE 3.—WEST GERMAN ELECTRICAL EXPORTS TO FINLAND (£000)

Products	1953	1954	Jan.-Sept., 1955
Generators, motors and rotary convertors	244	698	448
Complete generating sets	151	76	98
Phase compensators	30	56	43
Transformers and chokes	402	232	75
Switchgear	126	272	191
Electrical equipment for vehicles ...	26	36	37
X-ray equipment	62	145	103
Telephone equipment	195	441	385
Telegraph equipment	14	38	55
Wireless communication equipment...	37	75	58

Efforts to liberate trade moved forward when, as a consequence of flourishing exports, the import licensing of some raw materials and essential industrial requirements, excluding imports from the dollar area, became automatic at the beginning of last July. Though by these means about 40 per cent by value of imports were freed from quantitative restrictions, Finland's imports are still severely controlled as compared with those of other countries.

Timber and the timber using industries remain Finland's main source of wealth and account for over 81 per cent of her foreign exchange earnings. The principal partners in Finland's foreign trade are the United Kingdom, Soviet Russia, the United States, and, increasingly, Western Germany, apart from the Scandinavian countries.

Though Finland's electrical industry has been greatly expanded since the war, mainly because of the necessity to cope with the reparation demands, the uncertain supply situation of raw materials, coupled with outdated manufacturing methods, has handicapped her so far in gaining a foothold in world markets. Oy. Stroemberg A.L., employing some 5,000 people, is the main Finnish electrical manufacturer of heavier equipment, producing transformers, switchgear and some rotating machinery. Cables, wires, incandescent lamps, insulators, lifts and hoists, radio sets, meters, and telephone equipment are also manufactured locally.

Finland's electrical imports are shown in Tables 1 to 3. As these tables reveal, Western Germany is Finland's main electrical supplier; power station equipment and telecommunication materials account for the bulk of German exports.

As in the case of the greater part of the former IBRD loans the proceeds of the March, 1955, loan totalling some £12 million will be used to expand and modernize the wood product industries and to provide additional supplies of electric power. About three-quarters of this loan will be used for the purchase of equipment in Europe; the remainder will be spent in the United States. This loan will finance one-fifth of the total cost of the projects; the rest will be met from Finnish sources.

The equivalent of £4 million has been allocated for two power projects, one for a 100 MW plant in the north of the country to supply the national grid, the other, a 30 MW station in the western part, will initially supply the regional grid only. One power station on the Henijiki River in Finnish Lapland is to be built by Imatran Voima Oy., of Helsinki, either on the Lunsua or Ossauskosy Rapids. The power production from hydro stations situated on this river already accounts for one-third of the country's output. Another project, the Kaltimo Rapids station, will be carried through by Oy. Kaukas, of Helsinki.

Market possibilities undoubtedly exist for heavy electrical plant (for water and steam power stations), transformers and switchgear, electric vehicle equipment (starting and control gear), sparking plugs, radio and lighthouse installations (navigational aids), X-ray apparatus and household appliances.

Eastern Region Railway Electrification

ENGINEERS of the Eastern Region of British Railways have begun work on the relaying of the 9¾ miles long Churchbury loop line with new flat bottom track and timber sleepers. This work, costing some £120,000, is preparatory to the electrification and reopening to passenger traffic of the loop, which is included in the electrification scheme for the Liverpool Street-Enfield Town, Chingford, Hertford East and Bishops Stortford lines. The present track is below the standard necessary for operation with electric rolling stock.

World's Longest Transmission Line Span

Crossing the Sogne-Fjord of Norway

By KARL A. BENTZEN*

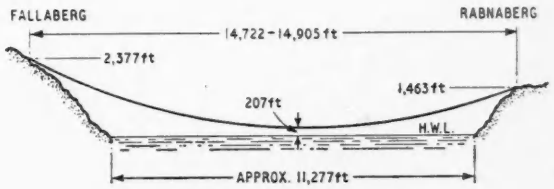
IN recent years many high voltage transmission lines have been built across fjords and sounds in West Norway, utilising a series of long spans. A great number of them can be found in the county of Sogn og Fjordane, where the Sogne-fjord span, at present the world's longest, is situated.

The horizontal distance between the anchor towers on both sides of the fjord varies between 15,800ft and 16,000ft for the four conductors which have been strung. The elevation of the anchor tower at the south side of the Sogne-fjord is about 1,570ft, and on the north side about 2,560ft. The span's lowest point is 223ft above the top level of the fjord and the sag is thus about 1,870ft.

The crossing is part of a new 60 kV transmission line between the two communities of Vik and Hermansverk, on opposite sides of the fjord. The power system in this region will later be working on 150 kV, which has been catered for in the design.

Four conductors, 164ft apart, have been strung, the fourth conductor acting as "stand by" for the others. Each conductor is made up of 37 galvanised steel wires with an ultimate strength of about 114 tons/sq in. The core wire has a diameter of 3·6 mm and the remaining 36, arranged in three layers, a diameter of 3·2 mm. The total cross-section is about 300 sq mm (0·24 sq in) and diameter of conductor about 23 mm (0·91in). The tension in each conductor is about 15 tons. The conductors were delivered in lengths of 16,700ft on four drums, the gross weight of each drum being about 14 tons.

Tension is transferred to the anchor towers through six parallel insulator strings. As already mentioned, the pull is 15 tons, and each chain thus takes 2·5 tons, the ultimate strength of each chain being 11·5 tons. The conductors are fastened by means of specially designed conical wedge tubes.

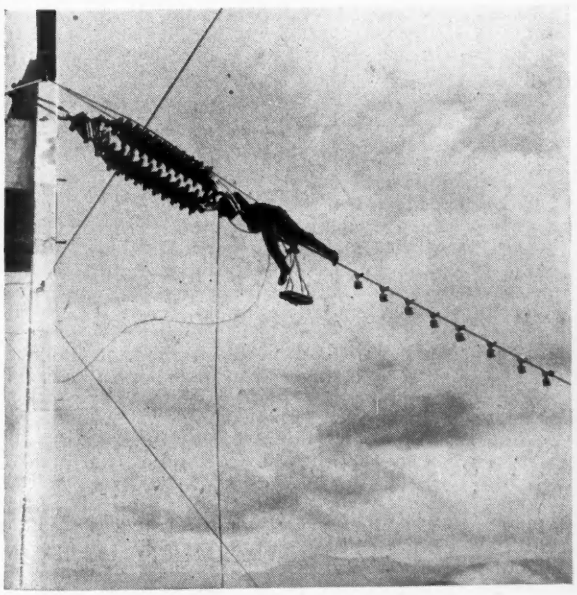


Cross section of the Sogne-fjord crossing

In conductors freely supported and with comparatively long spans, heavy vibration is a usual occurrence with certain winds. These vibrations give varying bending stresses to the conductors in addition to the tension stresses, and might in course of time be fatal to the conductors. The most dangerous point is close to the tension clamps and in order to reduce the vibration at these points, eight vibration dampers of the Elgra type are used at each end of the conductors. These can be seen in one of the photographs.

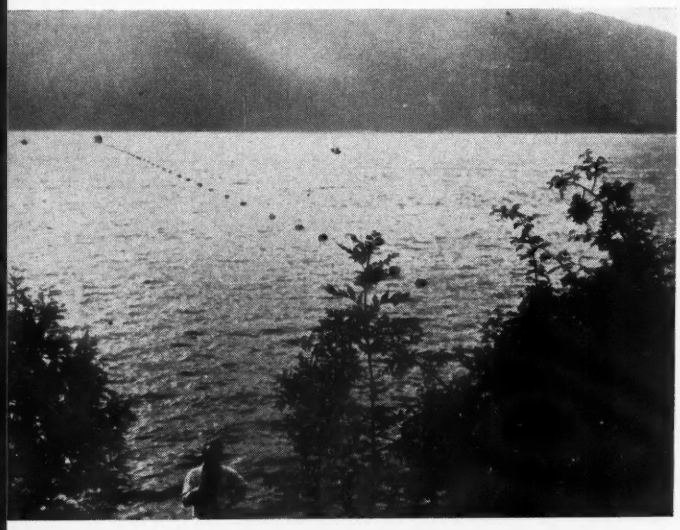
When erecting long spans across fjords the preparatory work necessary represents a substantial part of the entire job. In order to bring to the tower sites the necessary materials for the cast-in-situ concrete anchor towers, and equipment for stringing the conductors, many aerial ropeways of comparatively great length had to be built on both sides of the fjord. On the south side a temporary

* A/S Betonmast.



The eight Elgra dampers can be seen here

Line termination



Drums floating on the fjord to carry the conductor

quay also had to be built. A tractor was used on the south side of the fjord for the final tensioning and in order to bring this up the mountainside to the tower site, an old mountain path had to be improved.

Of other preparatory works can be mentioned the laying out of draglines, the preparing of safe anchoring for tackles and stopclamps, the making of several openings through the forest and bushes on either side of the fjord from the water level and up to the towers.

Further special mounting clamps had to be designed for the stringing of the conductors. Excellent communication was important, and for this purpose three sets of "walkie-talkies" were used, in addition to several field telephones.

When all the preparatory work was done, an ordinary small cargo ship brought the conductors to the site. All drums were placed in the ship's hold. The laying out and stringing of the conductor was done by means of a dragline and winch, the free end of the conductor being brought up to the anchoring tower on the north side. When the conductor was fastened to the tower, the ship went across the fjord and in order to keep the laid out conductor at water level, it was fastened to empty petrol drums at every 70-100ft.

On the south shore the conductor was temporarily fastened to a stopping clamp on the beach and the remaining part of the conductor coiled on the beach. Each crossing took about an hour.

The next step was to hoist the end up to the anchoring tower. When the coiled conductor on the beach was fully hoisted, the stopping clamp was released and the stringing started by means of tackles and the tractor winch. The floating petrol drums across the fjord were released successively as the conductor was raised and the sag was controlled by tachymeter readings.

The span was designed, and construction was undertaken, by A/S Betonmast, Oslo, Norway, the conductors having been produced by the Whitecross Company, Ltd., England.

United States Electrical Industry

A REPORT on the economic and commercial conditions in the United States of America, prepared by members of the staff of H.M. Embassy in Washington, has recently been published (H.M. Stationery Office, price 7s 6d, by post 8s). While the report contains much of general interest to British exporters, from the electrical point of view the information is somewhat meagre. This criticism also applies to the information given regarding the American electrical manufacturing industry.

The electrical section of the report is mainly concerned with electricity production and consumption. This states that there were considerable increases in both the output of electricity and revenue received during 1954, which contrasted with the temporary decline in activity for the United States economy as a whole. The use of electricity in 1954 was 6 per cent and revenue 7 per cent higher than in 1953. All classes of consumers participated in this growth, although residential and rural users were responsible for the largest portion of the gain. Industrial use of electricity showed only a 3 per cent rise. The Atomic Energy Commission now takes 2 per cent of all privately produced electric power and 7 per cent of the nation's total electric power production.

Residential and rural consumers contributed almost 43 per cent of total revenue although they consumed somewhat less than one-third of the total kWh sales in 1954. To-day's residential consumer uses an average of 2,540 kWh annually at a cost of 2·7 cents per kWh, while ten years ago he used 1,229 kWh at a cost of 3·4 cents. This has meant that the average consumer has doubled the use of power in his home since 1945, while his bill has increased only 60 per cent. The increasing number of labour-saving home appliances, such as washing machines, waste disposal units, refrigerators and deep freezers, together with radio and television sets and air conditioning units, have been largely responsible for the rise in average use, and indications are that this trend will continue in the future.

It is estimated that the demand for electricity will grow to such an extent in the next ten years that the industry will have to double its present generating capacity. Private utilities spent $2,800 million on construction during 1954 and it was anticipated that a similar amount would be spent in 1955. Total expenditure by the electrical utilities, public and private, was about $4,000 million in 1954. Expenditure by private utilities has totalled $18,000 million since the end of the war and capacity has increased by 100 per cent. If present estimates of growth are correct, private expenditure will have to reach between $4,000 and $5,000 million annually by 1965.

The electrical equipment industry in the United States has been growing rapidly during the last few years. In 1953 production of heavy equipment amounted to about $3,750 million; exports were $96 million and imports $10 million (of which $7·7 million represented emergency procurements by the Government of war material understood to be of a type not used for power production). Total sales by the whole of the electrical equipment industry in 1953 were about $17,000 million. Exports were about $803 million and imports $44 million.

Dealing with British exports to the United States, the report says that many opportunities for the export of heavy electrical equipment (such as generators, turbines and transformers) are presented by contracts which are open to public tender. Although the award of Federal contracts to foreign concerns is subject to the requirement of the "Buy American" Act, United Kingdom manufacturers have been successful in obtaining a number of such contracts during the last few years.

NEW ELECTRICAL EQUIPMENT

Diesel Generating Set

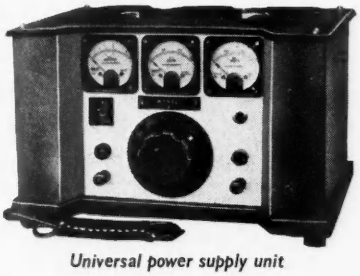
J. & H. McLAREN, LTD., Leeds, have redesigned their 55 kW diesel electric generating set to weigh less, take up less space yet have a superior performance. The new model has a cleaner and more compact appearance and will also cost less.

The main change is in the switchboard, which is now mounted on shockproof feet above the alternator. The redesigned set weighs about 3 tons 9 cwt, a reduction of 3 cwt on the previous model, and is 2ft 6in shorter. The height and width remain unchanged.

The new switchboard is of a totally enclosed, dead front design, accommodating meters, fuses, synchronising lamps, etc. Many of the components used in the old McLaren "7 Star" generating set are retained. For example, the windings of the alternator and exciter are identical. The fuel tank is now built in the baseplate, thus lowering the centre of gravity. Spares and service facilities are available throughout the world.

Power Supply Unit

A power supply unit has been developed by HOUSEHOLD ELECTRIX, LTD., 47-49, High Street, Kingston-on-Thames, to give laboratories and other institutions a reliable and easily controlled source of either direct or alternating current as required. Built into a case measuring 15in by 11in by 9½in, it provides for an input voltage

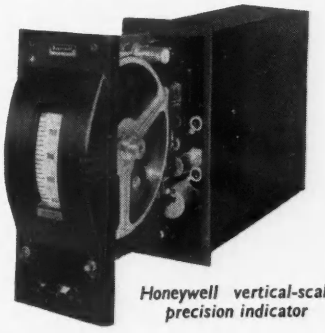


Universal power supply unit

of 230 V a.c. and will give an output of 0-270 V a.c. or 0-225 V d.c., the current rating being 2·5 A. The unit is fitted with a "Variac" transformer and can be regulated to an accuracy of one volt. The price is £55.

Vertical-Scale Indicators

HONEYWELL-BROWN, LTD., Wandsworth Road, Perivale, Middlesex, have introduced vertical-scale precision indicators which enable five instruments to be mounted in the panel space needed for two circular scale models. The sensitivity of these instruments is ½ per cent of the scale span and the accuracy is within ±0·2 per cent of the scale span. The rotating scale has a length of 28⅝in,



Honeywell vertical-scale precision indicator

5in of which is visible through the window, and the complete indicator chassis can be slid out from the front for inspection and service without putting it out of operation.

Magnetic Playback Attachment

A magnetic playback unit for their 16 mm sound projectors of the "Stylist" and "Educational" range has been introduced by SIMPLEX-AMPRO, LTD., 167-169, Wardour Street, London, W.1. With the attachment it is possible to play back previously made magnetic sound recordings, giving all the additional advantages of true-to-life magnetic sound reproduction together with full frequency response range and ample volume. It consists of a magnetic head attachment which can be fitted to the existing optical sound head, and a small pre-amplifier unit to provide the necessary gain and frequency correction required. Fitting the unit is a relatively simple matter, but its adjustment requires a certain amount of skill and special equipment.

The pre-amplifier is connected to the projector by three leads—to mains, to magnetic head, and to gramophone/microphone input at the rear of the projector. When not in use it is stored in the projector spares tray. The price, including fitting, is £53 10s.

Sigma Spot Welder

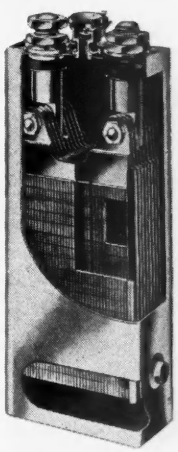
The latest addition to the range of Sigma equipment made by QUASI-ARC, LTD., Bilston, Staffs, is a spot welder which combines the reliability of the Sigma process with the high production speed of spot welding. Mild steel, stainless steel and copper based alloys can be spot or plug welded up to ¼in thickness, and as the weld area is shielded by inert gas, the weld is free from oxide inclusion and has a smooth and clean surface.

Once the controls are set for the required conditions the process is automatically controlled. The operator positions the torch over the joint, presses the trigger, and in two to five seconds the weld is complete and the torch is ready for the next weld. Welding is from one side only, thus avoiding difficulties where access from both sides is impossible, and no forging pressure is required. Filler wire is automatically fed into the weld pool and controlled so that the "sink holes," common with some other spot welding methods, are eliminated.

High production rates are possible and, in addition, the spot welder can be converted in a matter of seconds from spot to seam welding.

High Performance Batteries

Savings of 20 to 25 per cent in weight, space and cost have been achieved with a new range of high performance cells for engine starting just announced by NIFE BATTERIES, Redditch, Worcestershire. These are known as DL high performance cells. The use of a larger number of thinner plates has increased the effective plate area and reduced the internal resistance. Improved methods of perforating the steel pocket ribbon give a 10 per cent increase in perforated area and a corresponding increase in performance. Modifications to the methods of interlacing the pocket strips and improved active materials give better conductivity of the plate section. Cell crates have been redesigned and the use of nylon suspension insulators results in greater mechanical strength and resistance to wear under the most adverse conditions.



Typical cell from the new NIFE DL range

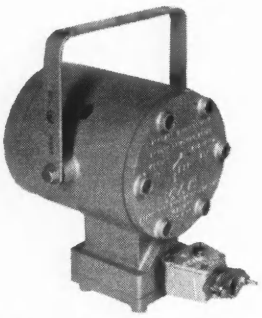
Available in a complete range of 15 sizes from 65 Ah to 315 Ah, these new cells have been specifically designed for such duties as starting oil engines.

Flameproof Loudspeaker

Sound broadcasting within industry can now be extended still further following the introduction of a new loudspeaker horn driving unit for use in inflammable atmospheres. Made by the GENERAL ELECTRIC CO., LTD., Magnet House, Kingsway, London, W.C.2, this is the first unit of its kind to receive the Ministry of Fuel and Power's certificate approving its use in atmospheres covered by Groups II and III of B.S. 229/1946 dealing with flameproof equipment.

The driving unit is a high efficiency

pressure operated device suitable for use with a projector horn or any well-designed re-entrant horn having a minimum air column length of 20in. The speech coil and driver section, the magnet assembly and the line matching transformer are all totally enclosed



G.E.C. flameproof horn loudspeaker driving unit

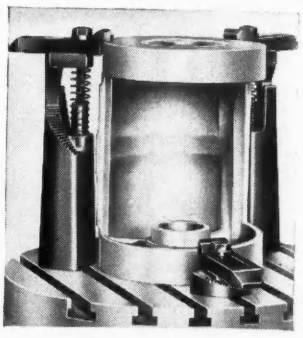
in a substantial aluminium alloy cast flameproof case.

Maximum reliability is ensured by the enamelled copper wire on the speech coil winding, with beryllium copper lead-out strips. The multi-ratio transformer provides various line impedances between 600 and 30,000 ohms; the power fed from the loudspeaker line to any unit may thus be individually adjusted to suit varying site conditions. The maximum power handling capacity is 10 W.

Helical Clamps

The ROCKWELL MACHINE TOOL CO., LTD., Welsh Harp, Edgware Road, London, N.W.2, is now marketing Rockwell helical clamps, made in sixteen sizes, the smallest being able to clamp workpieces up to $1\frac{3}{4}$in in height and the largest up to $15\frac{1}{2}$in in height. These have a helical "staircase" consisting of small steps extending around the axis of the clamping bolt. This supports the lower stepped end of the clamp supporting member, which is arranged for rotary adjustment about the clamping bolt.

The supporting clamp carries an off-set clamping strap arranged for



Rockwell helical work clamps in use

longitudinal adjustment in a groove formed in the upper surface of the supporting member. The clamping strap can be reversed by 180 deg. A compression spring between these two members facilitates the desired height adjustment. The clamps are manufactured from high grade spheroidal precision castings and the clamping bolt and the tubular nut are manufactured from heat treated steel.

LIGHTWEIGHT BATTERIES

PRIVATE research work over a number of years has led to the successful production of what seems to be a novel type of secondary battery. We recently had the opportunity of seeing the results of this work, which is now vested in the Lightweight Battery Co., Ltd., Copthall House, 13, Copthall Avenue, London, E.C.2, a company formed by the inventor and others for the production of the batteries on a considerable scale when circumstances permit.

The cells dispense with the heavy lead support plates, and also with separators, in the conventional form. The advantages are claimed to be a very low internal resistance leading to low heat generation on heavy discharges, and permitting very heavy discharges, without apparent damage; a capacity for quick charging; and low weight. The design is the subject of British and foreign patent applications. The construction may be seen from Fig. 1, an opened-up prototype element for a traction cell made up of six such elements in a common case. Each of these elements is in effect a double cell having two primary and two secondary electrodes connected in parallel.

The inner part consists of a basic glass tube, covered with a lead foil from which comes the positive connection in the form of the antimonial lead bar seen entering the top connector plate. The positive active oxide material in the form of a paste is coated on the lead foil. This is protected from mechanical disruption due to gassing by a thin layer of acid-resisting but wholly pervious material held in place by a fine mesh plastic fabric which is also acid resisting. This outer covering is secured by an open helix of thin plastic cord.

The negative is of metallic gauze and due to the principles of cathodic corrosion protection is not attacked by the acid. This is coated with active material, then covered by a thin layer of insulating impervious plastic, a layer of lead foil representing the second positive, and a repetition of the further coverings described for the first positive.

The second, outer, negative is also of metallic gauze coated with active material and a plastic layer as for the first. The twelve positive connections of a complete six-element cell are "commoned" in the lead connector plate and the twelve negative connections are commoned up separately. Such a cell assembled is seen in Fig 2. The six elements are packed close together and the dimensions of the cell are $2\frac{5}{8} \times 4 \times 20$in. The capacity of this cell at the five-hour rate is about 120 Ah and the output voltage about 2·0. The weight is 16 lb.

The power/weight ratio of standard traction cells in use at the present time is, at the two-hour rate, between 5 and 7 Wh/lb. The cells described are claimed to have a ratio, at this rate, of about 12·5 Wh/lb, a striking difference. When delivering 500 A on an overload the output voltage of a cell fell only to 1·5 V, representing about 1 h.p. of output.

It is claimed that on large-scale production the cell is not expensive to make, and a smaller version of that described has been installed and operated for several months in a car, in place of the conventional battery. Both space and weight are considerably reduced.

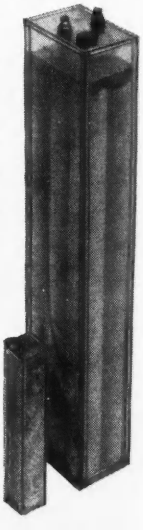
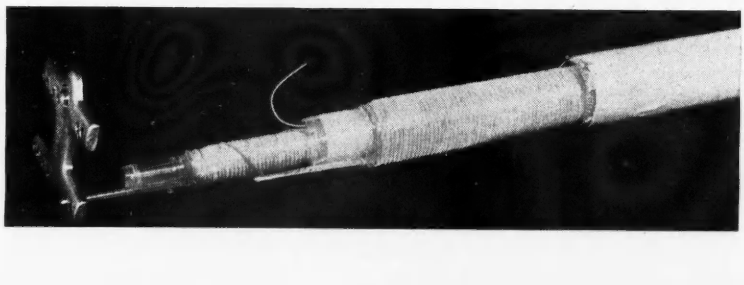


Fig. 1 (below).—Expanded assembly of a double element. Fig. 2 (right).—120 Ah traction cell and a smaller unit



GENERATION AND DEVELOPMENT

Glasgow All-Electric Houses

Glasgow Housing Committee has instructed the city architect to proceed with the planning of a group of 96 houses as part of the Gorbals redevelopment scheme. These are to be all-electric houses, with floor heating in the living room and halls, electric points and electric water heating. They will be built in the Rutherglen Road, Lawmoor Street and Ballater Street areas, which will be acquired compulsorily by the Corporation.

New Greenock Showrooms

New showroom premises are to be built at Greenock for the South of Scotland Electricity Board. They will be contained in a three-storey building to be erected on a site at the corner of High Street and Smith Street by the Board in conjunction with Greenock Corporation. On the ground floor will be extensive showrooms, offices and a demonstration hall. The first and second floors will incorporate dwelling houses. Of the total cost of £24,000, about £13,590 will be attributable to the showroom premises. The project has been submitted to the Scottish Department of Health for approval. The new showrooms are to replace the Board's present premises at Hunter Place, Greenock.

Electric Cooking but not Water Heating

Meriden R.D.C. is to pay £1,400 towards the cost of laying mains for its new houses in Stonebridge Road, Coleshill. Previously cables to municipal houses have been laid free. The Midlands Electricity Board told the Council that if the houses were fitted with electric cookers and immersion heaters there would be no charge, but if only a cooker were installed a £1,400 contribution would be required. The Council decided it would be unwise to commit itself to installing immersion heaters when trying to cut building costs.

Reinforcement Scheme

The South of Scotland Electricity Board has approved a scheme for the reinforcement of supply to Bathgate at a cost of £86,800, involving the construction of a new 33 kV substation at Paulville. The scheme, to begin this year, will be completed in 1958.

Ruling on Lake District Supply

To speed up the supply of electricity to the Deepdale Valley, Ullswater, the Lakes Planning Board some time ago agreed to allow overhead lines to be used for the greater part of the route, but the National Parks Commission objected, insisting that a two-mile length of cable should be laid underground. It is now announced that the Minister of Fuel and Power has overruled the Commission's objection. The work of providing the supply is expected to be completed by the autumn.

Reconstruction of N.C.B. Distribution

Durham County Planning Committee has approved proposals by the North Eastern Electricity Board for the reconstruction of the network which it is taking over from the National Coal Board at Kimblesworth Grange, Nettlesworth, Plawsworth, Sacriston, Heworth Colliery, Fence Houses, and Chilton Moor.

Hungarian Five-Year Plan

A five-year development plan for the electricity supply industry involving an investment of £195 million is under discussion in Hungary. The proposal, part of the 1956-60 industrial plan, has been put forward by the Working People's Party. It aims at increasing electric power output by 67 per cent by 1960. Besides the 200,000 kW Borsod station, the 225,000 kW Tiszapalkonya plant and the Pécsujhegy 90,000 kW station, the plan provides for the beginning of building of three other plants, at sites not yet announced, with a total capacity of 500,000 kW. In addition, the Ajka power works, serving the aluminium industry, is to be extended by 100,000 kW and a 132,000 kW plant started at Oroszlány.

Purchase of Athens Company

The Athens correspondent of *The Times* reports that the Greek Minister of Trade and Industry (Mr. Papaligouras) has announced the Government's intention to purchase the installations of the Athens-Piræus Electricity Co., a British concern, as part of its plan to take over all privately owned electric power stations and place them under the Government-controlled public power corporation. The Minister said that the Government would give the company notice in 1958 and negotiations should be complete by 1960.

Power Resources of Labrador

Development of one of the world's largest remaining untapped hydro sources—at Grand Falls on the Hamilton River, Labrador—is considered "sound, practical and economic." This is stated in a report to the British Newfoundland Corporation based on two years' study by the Shawinigan Engineering Co. and the Montreal Engineering Co. The report says that a continuous output of 3,000,000 h.p. can be assured at the Grand Falls site and an ultimate installation of not less than 4,000,000 h.p. would be justified on the basis of normal industrial load requirements. An additional 2,000,000 h.p. is available on the Hamilton River below Grand Falls.

The Grand Falls site can be developed in progressive stages. After initial work, costs would be relatively light. Large-scale transmission of power from Grand Falls to prospective load centres has been studied and presents no technical difficulties.

Underground Steam Station

What is said by the *Anglo-Swedish Review* to be the first large-size underground steam station is being built at Stenungsund on the Swedish west coast. Two boilers, each with a rating of 465 tons/hr, 135 kg/cm^2, 535 deg C, are being designed jointly by the Power Board and A. B. Svenska Maskinverken, which will construct them. Two 150 MW turbo-generators have been ordered from the Stal turbine works of Finspang.

The station is designed for two more turbo-generator sets and has space also for a future atomic power plant. Heavy oil will be used for firing the boilers. The total cost of the station is put at Kr.285 million (£19,650,000), which is said to be only 10 per cent more than for a conventional surface station. The maintenance costs are expected to be considerably lower.

World Bank Loan to Finland

On 22nd May the World Bank signed an agreement whereby Finland will be granted a loan of $15 million for the development and distribution of electric power. This is the sixth loan granted by the Bank to Finland since 1950 and brings the total sum lent to $65,300,000.

New Plant for Venezuela

A thermo-electric plant consisting of two 12,500 kW units is to be erected in La Fria, Venezuela, at a cost of 12½ million bolivares.

Egyptian Electric Railway

An electric railway is to be opened between the Egyptian capital, Cairo, and Helwan, a popular health resort famous for its hot sulphur springs, 15 miles south of the city. Modern air-conditioned coach trains will be used on the route and travelling time will be only 22 minutes, which is half the time taken at present. Top speeds of the new trains will be over 60 m.p.h. The trains have been constructed in Holland by Allan of Rotterdam, the electrical equipment being supplied by Siemens Schuckert of Germany.

Electric power for the new railway will be supplied by the Cairo Electricity and Gas Administration. Operation will be at 1,500 V d.c.

Financial Section

STOCKS and SHARES

STOCK EXCHANGE markets began this month looking undeniably unhappy in the face of such news as the increase in coal prices, the situation over the Standard Motors' factory reorganisation and the further claims for increased wages which followed immediately upon Mr. Macmillan's fresh warnings about the dangers of the wages-prices spiral. This spiral, coupled with the workings of the credit squeeze and high taxation, becomes an increasingly insistent theme at the many company meetings being held at this time of year: one chairman's speech after another deals with the problem of how to hold down prices while, at the same time, retaining sufficient earnings to finance business and development.

Electrical Shares

With so much obscurity affecting the early future of markets, investment is encouraged to turn towards the industries, such as electrical engineering, which seem to have the most promise from the long-term point of view. A lasting impression was made by some of the statements of Lord Chandos at this year's A.E.I. meeting, notably his indication that one basis of the company's planning is the tendency for the use of electricity to double itself every decade or so. Interests of many of the well-known electrical companies in the future of atomic power, electronics and automation add greatly to the investment appeal of the shares concerned. Considerations such as these have not inoculated the latter against the present market malaise, which is reflected in a string of declines in the accompanying price lists, but help to fortify the shareholder's confidence in the basic soundness of his investment.

Simon-Carves

It is announced by Simon-Carves that official consent has been given to the one-for-two scrip issue of which the company gave notice at the time of last month's dividend declaration and preliminary profits statement. These were the first results to be published since the successful public issue of the 5s ordinary shares in September last, at a price of 22s. They have been standing recently at about 32s 6d. The final dividend for 1955 is to be 17½ per cent, as compared with the 15 per cent payment anticipated earlier in the prospectus, which indicated a total of not less than 22½ per cent for the year now running. At that rate the yield on the shares works out at barely 3½ per cent, but the distribution now to be made encourages market hopes of a larger total for this year. Confidence in that respect is supported also by the expansion in 1955 earnings from under a million to nearly £1.4 million (before tax). Public interest in the shares is heightened by the company's association with G.E.C. in the field of nuclear power.

Bid for McMichael

McMichael Radio 5s ordinary were standing at about 8s before the news of a bid of 9s 3d per share on behalf

Price Changes in

Company or Board	Nom. Value	Middle price 4th June	Week's Rise or Fall	Dividend Previous	Dividend Last	Yield %	1956 Highest	1956 Lowest
Gilt-edged Stocks						£ s d		
Brit. Elec. 1968/73	100	75½	−1	3	3	3 19 6	80½	75
Brit. Elec. 1974/77	100	74½	−1		3	4 0 6	79⅝	73⅜
Brit. Elec. 1976/79	100	78½	−1	3½	3½	4 9 3	84	78½
Brit. Elec. 1974/79	100	89⅛	−1	4⅛	4⅛	4 15 0	95	88
Overseas Electric Supply								
Calcutta Elec.	£1	19/6		6†	6†	6 3 0†	20/9	19/-
East African Power	£1	19/6	−6d	7	7	7 3 6	21/3	19/6
Nigerian Elec.	£1	20/-		10	10	10 0 0	21/-	17/-
Palestine Elec. "A"	£1	21/-		Nil	Nil	Nil	21/-	21/-
Perak Hydro-Elec.	£1	16/-		10	10	—	17/6	14/9
Equipment and Manufacturing								
Aberdare Cables	5/-	11/-	−9d	17½	17½	7 19 0	13/6	10/6
Aerialite	1/-	5/-	−3d	88⅛	45*	9 0 0	6/9	5/-
Allen, W. H.	£1	75/-		20	20	5 6 8	78/-	67/-
Aron Elec. Ord.	£1	56/-		15	15	5 7 3	56/-	53/6
Assd. Automation	10/-	17/-xr		10	5	2 18 9	—	17/-
Assoc. Elec. Ord.	£1	67/6	−2/6	14	15	4 9 0	85/6	57/9
Automatic Tel. & El.	£1	57/6	−2/6	15	15	5 4 3	72/6	59/6
Babcock & Wilcox	£1	75/3	−1/3	15	15	3 19 9	85/6	64/-
Baldwin, H.	2/-	5/-		20	20	8 0 0	5/-	3/9
Bakelite	10/-	29/6	−6d	16	16	5 8 6	34/-	26/9
Berry's Electric	5/-	6/6		—	10‡	7 13 9	6/6	5/9
British Aluminium	£1	52/6	−6d	12	12	4 11 6	57/-	40/6
B.I. Callender's	£1	48/-	−3/-	10	12½	5 4 3	54/3	45/-
B.I. Callender's 6% Pref.	£1	21/9		6	6	5 10 3	22/6	20/3
British Thermostat	5/-	28/3		20	25	4 8 6	31/9	24/6
British Vac. Cleaner	5/-	6/6	−3d	30	15*	11 10 9	8/9	6/9
Brook Motors	10/-	37/9	−2/3	20	25	6 12 6	44/-	40/-
Brush Ord.	5/-	6/3	−9d	10	10	8 0 0	7/9	6/3
Bulgin, A. F.	1/-	4/9	−3d	45	50	—	5/3	4/3
Burco Dean	5/-	9/6		—	22½	11 16 9	13/3	8/6
Chloride El. Storage "A"	£1	62/-	−1/9	17½	17½	5 13 0	73/6	60/9
Clarke Chapman	£1	108/9	−1/3	20	22½	4 2 9	112/6	89/6
Cole, E. K.	5/-	15/6	−9d	27½	17½*	5 13 0	22/3	15/6
Cossor, A. C.	5/-	7/-	−6d	10	15	10 14 3	10/3	6/9
Crabtree	10/-	28/-	−6d	20	20	7 2 9	29/3	27/-
Crompton Parkinson Ord.	5/-	14/3	−3d	20	16*	5 12 3	15/-	12/3
De La Rue	5/-	18/9	−3d	20	30	8 0 0	20/3	15/-
Decca	4/-	27/6	−1/9	56½	43¾*	6 7 3	44/9	24/9
Desoutter	5/-	27/3		25	30	5 10 0	32/9	25/9
Dewhurst	2/-	7/-		24	30	—	7/3	5/3
Dictograph Tel.	2/-	6/3		20	20	6 8 0	6/9	6/-
Dubilier Condenser	1/-	4/-		25	25*	6 5 0	4/6	4/-
E.M.I.	10/-	26/3	−1/6	10	15	5 14 3	37/-	26/3
Electrical Components	5/-	13/3	−6d	20	25	9 8 9	16/-	13/3
Elec. Construction	£1	27/6	−1/3	15	8½	6 3 9	29/9	25/-
Enfield Cable Ord.	£1	14/-	−1/3	Nil	Nil	Nil	19/3	14/-
English Electric	£1	52/-	−1/9	12½	12½	4 16 3	66/3	47/3
English Electric 3¾% Pref.	£1	14/-		3¾	3¾	5 7 3	14/6	12/6
Ericsson Tel.	5/-	35/6	−1/6	20†	20†	2 16 3†	42/9	33/6
Ever Ready	5/-	27/9	−1/3	35	35	6 6 3	32/9	24/-
Falk Stadelmann	£1	37/6	−1/3	15	17½	9 6 9	45/9	37/6
G.E.C. Ord.	£1	53/9	−1/3	12½	14	5 4 3	65/6	50/-
G.E.C. 6½% Pref.	£1	23/9		6½	6½	5 9 6	23/9	21/3
General Cables	5/-	12/3	−6d	30	30	12 5 0	13/9	12/3
Greenwood & Batley	£1	46/3		17½	17½	7 11 3	47/6	45/-
Hackbridge Cable	5/-	22/9	−1/-	20	25	5 10 0	24/6	18/9
Hackbridge & Hewittic	5/-	19/3		25	30	—	22/-	17/3
Heatrae	2/-	4/9		15	15	6 6 3	5/1	4/9
Henley's	10/-	15/9	−1/6	10½	11½	7 6 0	19/9	14/-
Holophane	5/-	18/9		25	30	8 0 0	19/-	17/-

The above quotations are based upon middle prices in the Stock Exchange Daily Official List.
* After scrip issue. † Free of income tax. ‡ Dividend forecast.

of Radio and Allied Industries, and were subsequently marked up to within 6d of the latter figure. The £1 preferred ordinary shares, previously quoted at 17s 6d, also moved up towards the price of 22s 9d offered for them. McMichael's annual results had shown, about a fortnight previously, an approximate halving of both the trading profit and the rate of the ordinary dividend, which was reduced to 8 per cent. The Radio and Allied offer is conditional upon acceptance in respect of 90 per cent of both the classes of capital. The McMichael board's recommendation of acceptance was to be followed by a circular.

Electrical Investments

Company or Board	Nom. Value	Middle price 4th June	Week's Rise or Fall	Dividend Previous	Dividend Last	Yield %	1956 Highest	1956 Lowest
Equipment and Manufacturing—continued						£ s d		
Hoover	5/-	26/3	−6d	70	50	9 10 6	39/3	23/-
I.C.I.	£1	43/9	−1/6	10	10	4 11 6	49/9	41/3
Intl. Combustion	5/-	20/-	−6d	25	20*	5 0 0	25/-	15/3
Johnson & Phillips	£1	40/9		15	15	7 7 3	46/6	37/6
Lancashire Dynamo	£1	45/-		15	11*	4 17 9	49/9	40/9
Laurence, Scott	5/-	15/9		12½	15	4 15 3	16/9	13/3
Lister, R. A.	£1	34/3		9·3	10	5 16 9	35/3	27/6
London Elec. Wire	£1	50/-	+9d	12½	12½	5 0 0	52/9	46/5
Lucas, J.	£1	30/-	−2/6	7½	7½	5 0 0	40/3	31/3
Marryat & Scott	2/-	10/6		25	30	5 14 3	11/-	9/6
Mather & Platt	£1	55/6	−3/-	13·4*	15	5 8 0	65/3	51/6
Metal Industries	£1	18/9	−1/3	9	9	—	27/-	16/3
Midland Elec. Mfg.	£1	47/6		10	12½	5 5 3	48/6	43/6
Morphy-Richards	4/-	20/-	−1/3	35	50	10 0 0	27/3	20/-
Murex	£1	67/6	−6d	15	20	5 18 6	70/3	60/-
Newman Ind.	2/-	2/6		10	10	8 0 0	2/9	2/1
Oldham & Son	1/-	2/6		17½	20	—	3/-	2/4
Parnall (Yate)	5/-	5/9	−6d	14	12	10 8 9	9/6	5/6
Parsons, C. A.	£1	85/-		10	10	2 7 0	85/-	61/6
Plessey	10/-	66/-	−4/-	27½	30‡	4 11 0	87/6	56/-
Pye "A" Deferred	5/-	15/9	−3d	20	12½*	3 19 3	21/3	14/-
Revo	10/-	11/3		9	9	8 0 0	11/9	8/3
Reyrolle	£1	105/-		15	16½	3 2 0	110/-	81/-
Rheostatic	4/-	9/-	−6d	18½	12‡	5 6 9	—	8/3
Richardsons Westgarth	5/-	16/-		16⅜	16⅜	5 4 3	17/-	13/9
Scottish Cables	4/-	16/9	−1/-	27½	27½	6 11 3	17/9	15/9
Smith (England), S.	4/-	11/9	−9d	17½	17½	5 19 3	14/3	11/-
Southern Areas	£1	20/-		10	7½	7 10 0	28/9	20/-
Strand Elec.	5/-	7/9		17½	15*	9 13 6	8/6	7/3
Sturtevant	5/-	23/9	−1/-	14·4†	15†	3 3 3†	31/3	23/9
Sun Elec.	£1	36/-		15	20	11 2 3	37/6	36/-
Switchgear & Cowans	5/-	14/6	−3d	20	25	8 12 6	17/-	14/6
Taylor Tunnicliff	5/-	11/9		15	15	6 7 9	14/-	11/3
T.C.C.	10/-	43/3	−1/9	25	25	5 15 6	45/-	40/6
T.C. & M.	£1	30/-	−6d	8½	8½	5 13 3	34/-	26/-
Telephone Mfg.	5/-	7/6	−3d	10	10*	6 13 3	8/6	6/3
Thorn Elec.	5/-	17/-	−6d	20	15*	4 8 3	22/6	16/-
Thornycroft	£1	43/9	−1/3	15	15*.	6 17 3	49/9	41/3
Tube Investments	£1	61/3	−2/6	22½	14*‡	4 11 6	70/6	54/9
Vactric	5/-	13/9		10	15*	—	15/-	11/6
Veritys	5/-	9/3		12½	12½	6 15 3	10/-	6/9
Walsall Conduits	4/-	12/9	−3d	70	70	—	13/6	10/9
Ward & Goldstone	5/-	35/-	−1/3	50	30*	4 5 9	38/3	29/-
Watford	2/-	6/6		25	25	7 13 9	7/6	6/6
Westinghouse Brake	£1	77/6	−3/9	18	18	4 12 9	100/-	71/6
West, Allen	5/-	13/-	−9d	15	15	5 15 6	14/6	11/6
Wolf Electric	5/-	19/-		20	20	5 5 3	26/3	19/-
Trusts, Transport and Communications								
Anglo-Am. Tel.:								
A. Ord.	100	77	−2	6	6	7 15 9	80	66
Ord.	100	50		3¾	3¾	7 10 0	54	45
Anglo-Portuguese	£1	23/-	−6d	8	8	6 19 3	23/6	20/3
Brit. Elec. Traction:								
Def. Ord. "A"	5/-	17/-	−1/-	50	22½*	6 12 3	20/-	15/6
Cable & Wireless:								
Ord.	5/-	10/-	−6d	10	10	5 0 0	11/3	9/6
4% Loan	100	92		4	4	4 7 0	92½	88
Calcutta Trams	£1	23/-		6†	7½†	6 10 6†	26/3	23/-
Cape Elec. Trams	£1	18/3		5½	7½	8 4 6	20/3	18/-
Marconi Marine	£1	32/-		10	10	6 5 0	34/-	31/-
Oriental Tel. Ord.	1/-	73/6	−2/-	16	—	—	90/-	73/6
Telephone Rentals	5/-	10/9	−3d	12½	12½	5 16 3	11/9	9/9

L. E. W. Prospects

London Electric Wire Co. & Smiths turned to good account the conditions prevailing last year in their field of industry. At last week's annual meeting the chairman ascribed the substantial improvement in earnings to higher output throughout the group, which now employs capital of the order of £8 million. The dividend for the year was maintained at 12½ per cent on capital increased by 20 per cent through a "rights" issue of shares, and was well covered by earnings. His review of prospects included references to the effects of the credit squeeze upon business, and of rising wages and overhead expenses upon production costs. Orders showed a marked decline in the first four months of the year, and although this trend had shown signs of levelling off, Mr. Noel Smith felt that any forecast, at this stage, of the current year's results would be unwise. He had no hesitation, however, in declaring his confidence in the future. At 50s the £1 shares yield a round 5 per cent.

Associated Automation

New shares offered by way of rights to shareholders of Associated Automation have been changing hands fairly actively at a premium of between 2s and 3s on the issue price of 15s. Ordinary capital of the company is being doubled, to £1,400,000, as a result of this operation. The money is being raised to provide additional working capital and to further the group's new development plans by financing the purchase of another business. It is about nine months since, as Hall Telephone Accessories, the company first announced the intention of entering the fields of automation, electronics and instrumentation, beginning with the acquisition of the capital of James Gordon & Co. and the reorganisation of capital and management on lines appropriate to the new circumstances. Lately the company has announced a dividend of 5 per cent for 1955.

Dividends Declared

A 10 per cent improvement in the net surplus (after tax) of Scottish Cables during the year ended in March enables the company comfortably to maintain the ordinary dividend at a total of 27½ per cent for the third successive year. With the 4s shares quoted at 16s 9d the yield works out at a shilling over 6½ per cent. Ada (Halifax) 1s shares were called 1s 6d after the announcement of the reduction in profits from £300,000 to just under £200,000, and in the year's dividend from a total of 25 to 20 per cent. In both these instances the amount of the ordinary distribution is covered about twice by the net profits available for dividends and reserves.

REPORTS and DIVIDENDS

The London Electric Wire Co. & Smiths, Ltd.—The annual meeting was held on 30th May, Mr. N. Smith (chairman) presiding. In the course of his speech Mr. Smith said that the Australian factory, Fairfield Cables Pty., Ltd., in which they were interested, was steadily coming into full production, but this was a long-term investment and it could not be expected to earn dividends during the first few years of development.

While they were able to obtain sufficient supplies of electrolytic copper wire bars for the rolling mills, their principal concern last year was the fluctuation in the price of copper. During the latter part of 1954 and the early part of 1955 there was a move on the part of certain producers to stabilise the price of copper at a level which, in a measure, reflected the free world price. The Rhodesian Selection Trust, in May, 1955, decided to fix the price of copper sold to its customers in the United Kingdom and from then until the end of the year its selling price was on average £37 8s below the London Metal Exchange price. Their company and a number of other fabricators were not able to purchase any copper on the stabilised price basis because supplies were only adequate to satisfy the Trust's regular customers.

With the exception of nickel, which was in short supply, other raw materials caused no undue anxiety. The boom conditions prevailing last year enabled them to overcome the disability caused by the copper position, and the turnover of the group was a record both in volume and value. At the close of the year orders on the books were substantially greater than at the beginning of the year, but during the first four months of 1956 orders had shown a marked decline owing to the tightening of the credit squeeze and the high price of copper. After adjustments of outlook to the new economic conditions and, he hoped, a lower level in the price of copper, there should be a steady improvement in the sale of their products. In the field of research they had been actively developing new and improved insulations for both cables and winding wires, whilst in the metallurgical section new alloys were being perfected.

Telephone Rentals, Ltd.—In his statement circulated with the report and accounts for 1955, Mr. F. T. Jackson (chairman and joint managing director) says that the new business taken during the year constitutes a record, and looking ahead as far as the current year is concerned, business taken during the first four months is considerably in excess of that taken during the corresponding period of 1955. The activities and services rendered by the company necessitate a very considerable capital outlay and this, in due course, will receive the consideration of the directors.

Speaking of the company's overseas activities, the chairman says that in South Africa they continue to earn satisfactory profits while the Canadian business continues to expand. As explained at the last meeting they have taken a 50 per cent interest in an Australian business which operates in all the principal towns in Australia. The annual rental derived from the company there is quite substantial and business is making great progress. Their profit-sharing scheme continues to be very successful.

Scottish Cables, Ltd., reports trading profits for the year to 31st March last of £367,281, as compared with £338,514 for 1954-55, to which is added investment income of £55,666, making £422,947. Taxation absorbs £207,186 and the net profit is £184,114 (against £167,181). General reserve is allocated £75,000 and it is proposed to pay a final ordinary dividend of 20 per cent, again making 27½ per cent for the year. The balance carried forward is £65,033 (against £55,921 brought in).

The Morgan Crucible Co., Ltd.—The gross profits for the year ended 31st March last were £2,218,149, as compared with £2,060,482 for the preceding year, and after providing £1,096,444 for taxation, the net balance is £1,121,705 (against £1,021,613), of which £1,088,643 is attributable to the parent company. General reserve receives £225,000 and it is proposed to pay a final dividend of 6¼ per cent, and a centenary bonus of 1 per cent, making 11 per cent for the year. For the previous year the total distribution was 17½ per cent, including a bonus of 2½ per cent, which was paid before a 75 per cent scrip issue. The balance carried forward is £59,355 (against £48,897 brought in).

Crompton Parkinson, Ltd., have declared an interim ordinary dividend of 4 per cent (unchanged).

R. A. Lister & Co., Ltd., have declared an interim dividend of 2½ per cent (unchanged).

New Companies

Nuclear Constructions, Ltd.—Registered 3rd May. Capital £1,000. To design, construct, equip and manage power stations, including in particular atomic power stations; to design and construct nuclear reactors and atomic plant, etc. Solicitors: Holmes, Son & Pott, 3, London Wall Buildings, E.C.2.

J. R. Parsons (Electrical) Co., Ltd.—Registered 26th April. Capital £500. Wholesale and retail dealers in electrical, mechanical, motor, telephonic and telegraphic equipment, etc. Directors: J. R. Parsons and Marjorie Parsons. Regd. office: 49/50, Calthorpe Road, Edgbaston, Birmingham.

S. Collins (Electrical), Ltd.—Registered 11th May. Capital £1,000. Electrical engineers, electrical installation contractors, manufacturers of and dealers in radio and television sets, etc. Directors: S. Collins, Mrs. Jean M. Harvey and J. M. Heap. Regd. office: 7, Church Lane, Adwick Le Street, near Doncaster.

S.F.E.A.T.-Kasenit Furnaces, Ltd.—Registered 14th March. Capital £10,000. To enter into an agreement with Kasenit, Ltd., and Societa Forni Electrici Alta Temperatura and to carry on the business of makers and manufacturers of and dealers in boilers, furnaces, tubes, fittings, etc. Solicitors: Clifford-Turner & Co., 11, Old Jewry, E.C.2.

Elpan Controls, Ltd.—Registered 13th April. Capital £1,000. Manufacturers of and dealers in electronic, electro-mechanical, scientific and electrical precision instruments, control gear, dynamos, generators, switches, etc. Directors: A. E. Gostling and T. Jackman. Regd. office: 466, Bath Road, Slough, Bucks.

M. & B. Electrical, Ltd.—Registered 29th March. Capital £100. Electrical engineers and contractors, etc. Directors: M. B. Mitchison and Phyllis F. Bishop. Regd. office: 42, Dingwall Road, Croydon, Surrey.

Ernest Lee (Electrical Services), Ltd.—Registered 23rd March. Capital £500. Directors: E. Lee and Mrs. Gertrude H. M. Lee. Regd. office: 56, Lloyd Street North, Manchester.

Don Kenyon Electrical (Nottingham), Ltd.—Registered 24th March. Capital £1,000. Electrical, radio, sound, television, refrigerating, mechanical and general engineers, etc. Regd. office: 512, Derby Road, Nottingham.

S. Kershaw (Electrical), Ltd.—Registered 27th March. Capital £2,000. Manufacturers of and dealers in electrical goods of all kinds, etc. Directors: S. Kershaw and Mrs. Elly Kershaw. Regd. office: National Provincial Bank Chambers, Five Ways, Birmingham, 15.

Hartley Wilkinson, Ltd.—Registered 27th March. Capital £10,000. To acquire the business of electrical and radio engineers carried on at Keighley as "Hartley Wilkinson," etc. Directors: H. Wilkinson and Mrs. Elsie Wilkinson. Regd. office: 29/31, North Street, Keighley.

Increases of Capital

Connollys (Blackley), Ltd.—Increased by £600,000, in £1 ordinary shares, beyond the registered capital of £600,000.

Automatic Coil Winder and Electrical Equipment Co., Ltd.—Increased by £190,000. in £1 shares, beyond the registered capital of £10,000.

Bankruptcies

B. J. Tanner, residing and lately carrying on business as B. J. Tanner & Son, at 48, Gibbon Road, Peckham, London, S.E.15, as electrical engineers and contractors.—Receiving order made 16th May on debtor's own petition. First meeting 13th June and public examination 17th July, both at Bankruptcy Buildings, Carey Street, London, W.C.2.

A. W. Truman, carrying on business as Trumark Electrical, at 24, Verulam Avenue, London, E.17, electrical engineer.—Public examination 3rd July at Bankruptcy Buildings, Carey Street, London, W.C.2.

P. C. Jarvis, Cavan's Cottage, Stafford Road, Huntington, Cannock, Staffs, electrician.—Public examination 17th July at the Court House, Lichfield Street, Walsall.

D. E. Pitchers, 89, Gorleston Road, Oulton Broad, Lowestoft, electrician, formerly trading at 13, Tann Lane, Caister-on-Sea, Norfolk, radio and electrical engineer.—Last day for receiving proofs for dividend 13th June. Trustee, Mr. F. R. D. Walter, Castle Chambers, Opie Street, Norwich, Official Receiver.

Helier Electric (Colchester), 253, Mersea Road, Colchester, Essex, electrical engineers.—Receiving order made 14th May on a creditor's petition.

R. Phœnix, 38, Wilford Road and 36, Beech Avenue, Nottingham, television, radio and electrical dealer, trading under the style of Beech Avenue Radio Stores.—Receiving order made 14th May on debtor's own petition. Public examination 2nd August at the County Court House, St. Peter's Gate, Nottingham.

Clean Air Bill

WHEN the Clean Air Bill was discussed in committee by the House of Lords, Lord Milner moved an amendment to Clause 1 (Prohibition of Dark Smoke from Chimneys) to eliminate the defence that the emission of black smoke was caused by lighting up a cold furnace, the failure of apparatus or the use of unsuitable fuel, suitable fuel being unobtainable. He said that the Bill, by providing these new defences, would worsen the law on this subject.

Lord Kilmuir, Lord Chancellor, said the Government came to the conclusion that it would be wrong to say there could never be any exceptions. Concerning the defence "that the contravention was solely due to the lighting up of a furnace which was cold," he said that it would fail if the offence was due to inadequate plant or out-of-date machinery or the like, because then it would not be solely due to the heating up.

Earl Jowitt suggested the addition of the proviso "Provided always that the furnace in question is shown to be up-to-date or efficient."

Lord Kilmuir gave an undertaking that this point would be considered by the Government, and the admendment was withdrawn.

Discussing an amendment to Clause 3 (Requirement that New Furnaces Shall be so far as Practicable Smokeless), the Earl of Munster, Minister without Portfolio, said the clause applied to the installation of a furnace but he was advised that this would also cover the construction of a furnace *in situ*. He would consider at a later stage whether an amendment should be made to include the substantial reconstruction of a furnace.

The Bishop of Sheffield moved to amend Clause 6 (Requirement that New Furnaces shall be Fitted with Plant to Arrest Grit and Dust) so that it would apply to furnaces which burnt pulverised fuel or solid fuel in any other form, at a rate of 1 cwt an hour or more, thus substituting "1 cwt" for "1 ton." Lord Rochdale favoured 5 tons while Lord Jessel thought the figure should be 3 tons.

The Earl of Munster said that it was only after considerable discussion in the Commons that it was decided to reduce the figure to 1 ton; he thought it would be quite unreasonable to reduce this figure to 1 cwt, and equally unreasonable to make it 5 tons.

Lord Rochdale moved to change the definition of smoke to read "includes emissions containing gas and airborne particles consisting essentially of carbonaceous material and includes soot, ash, grit and grit particles emitted in smoke." He said the present definition in the Bill was not sufficiently precise.

The Earl of Munster said that the fact that smoke was not defined comprehensively in existing legislation had not caused any difficulty in the courts or to local authorities. The definition now proposed might be a hindrance, giving rise to some unnecessary technical arguments.

Lord Rochdale said this was the first occasion when it had been necessary to measure smoke in precise terms; that was why he wanted a more precise definition of what was to be measured.

The Earl of Munster gave an undertaking to consider this matter further, and the amendment was withdrawn.

The committee stage was completed.

Victoria's 220 kV Grid

ANOTHER stage in the development of Victoria's power transmission grid was marked by the opening recently of the State Electricity Commission's new switching station at Rowville, just north of Dandenong. The new electricity grid will operate at 220 kV, the highest voltage for bulk power transmission so far employed in Australia. It will form the backbone of a greatly augmented power supply system for the "all-electric" State which is now within a few years of accomplishment. The Rowville switching station will be a major junction for the transmission of electricity generated at the Latrobe Valley brown coal power stations and the Kiewa and Eildon hydro-electric stations.

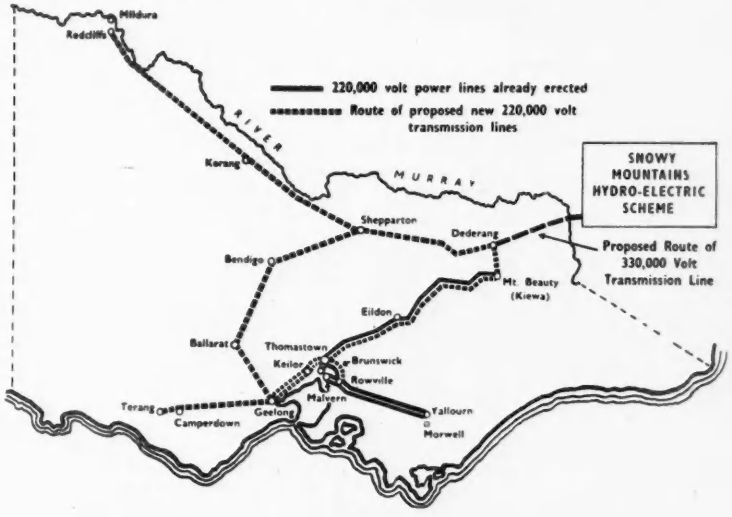
The State Electricity Commission has just completed a 220 kV line around the north-eastern perimeter of the metropolitan area from Rowville to Thomastown, which now provides interconnection between the new Yallourn and Kiewa transmission lines, already in operation.

Further developments of this new 220 kV system are now under way. The S.E.C. is to erect a transmission line from Kiewa to Shepparton and from Shepparton the line will continue on to Bendigo. Eventually the whole of central Victoria will be encircled by 220 kV transmission lines continuing on from Bendigo via Ballarat and Geelong back to Melbourne.

Other main power lines are planned to run from Shepparton right along the Murray Valley to Mildura, and from Geelong to Camperdown, and possibly further on to Terang. The total length of this power grid when it is completed will be more than 1,000 miles. The 220 kV conductors will be supported on steel towers, most of which will be 130ft high and some 150ft.

The new transmission system is needed to cater for Victoria's rapidly growing power needs, which will be at least double the present demand within the next eight to nine years. The distribution network already covers over two-thirds of Victoria and is being rapidly extended.

The S.E.C. is also planning the transmission line which will carry Victoria's share of Snowy Mountains hydro-electric power. This new line from the Snowy area will operate at 330 kV and will link up with the Victorian grid at Dederang.



NEW PATENTS

Electrical Specifications Recently Published

The numbers under which the specifications will be printed and abridged are given in parentheses. Copies of any specification (3s 0d each including postage) will be obtainable after 13th June from the Patent Office, 25, Southampton Buildings, London, W.C.2.

1950

24013. Ericsson Telephones, Ltd., and Acton, J. R.—Cold cathode electron discharge devices. 2nd October, 1951. (750211.)

1951

15939. Beresford & Son, Ltd., J.—Control systems for electric motors. 7th July, 1952. (750291.)

1952

2105. Standard Telephones & Cables, Ltd.—Signal transmission systems. 25th January, 1952. (750125.)

17597. Siemens-Schuckertwerke Akt.-Ges.—Semi-conductor devices. 11th July, 1952. (750134.)

19865. Licentia Patent-Verwaltungs-Ges.—Protective system for transportable electrical apparatus. 6th August, 1952. (750136.)

25672. General Electric Co., Ltd., and Beesley, J. H.—Automatic telephone systems. 31st January, 1955. (750139.)

27972. Lacey, C. L.—Electric discharge tube apparatus. 6th November, 1953. (750224.)

28254. Licentia Patent-Verwaltungs-Ges.—Methods of electrostatically spray-coating articles. 10th November, 1952. (750299.)

29981 and 31651. British Broadcasting Corporation.—Television cameras. 1st December, 1953, and 15th March, 1954. (750225 and 750227.)

1953

14. Beresford & Son, Ltd., J.—Control systems for electric motors. 21st December, 1953. (750302.)

3270. Philips Electrical Industries, Ltd.—Cathode-ray tuning indicators for visually indicating syntony. 5th February, 1953. (750304.)

5739. General Electric Co.—Automatic electric switches operating in response to circuit conditions. 2nd March, 1953. (750404.)

5831. Standard Telephones & Cables, Ltd. (International Standard Electric Corporation).—Radio frequency transmission line arrangements incorporating gas-discharge tubes. 3rd March, 1953. (750308.)

6202. Sperry Rand Corporation.—Automatic frequency control systems. 5th March, 1953. (750151.)

8101. General Electric Co., Ltd., and Waldram, J. M.—Electric lighting equipment. 24th March, 1954. (750157.)

8478. National Research Development Corporation.—Voltage stabilising circuits. 28th June, 1954. (750312.)

9147. Communications Patents, Ltd.—Dielectric heating processes. 2nd July, 1954. (750235.)

9830. Marconi's Wireless Telegraph Co., Ltd.—Cathode-ray tubes. 12th April, 1954. (750310.)

10575. Standard Telephones & Cables, Ltd.—Arrangement for dividing the frequency of a train of periodically recurring pulses. 17th April, 1953. (750316.)

11256. Metropolitan-Vickers Electrical Co., Ltd.—Control of electrically driven mine winders, hoists and the like. 2nd April, 1954. (750236.)

11730. Benjamin Electric, Ltd., and Long, H. H.—Lighting fittings. 6th April, 1954. (750129.)

12358. Chromatic Television Laboratories, Inc.—Cathode-ray tubes for colour television. 4th May, 1953. (750237.)

13579. Murphy Radio, Ltd.—Synchronising electronic time bases. 14th May, 1954. (750162.)

14394. General Electric Co., Ltd., and Robins, W. P.—Automatic frequency control of electric oscillation generator systems. 10th May, 1954. (750132.)

15084. Standard Telephones & Cables, Ltd.—Electrical selection equipment. 21st May, 1954. (750324.)

16024. Marconi's Wireless Telegraph Co., Ltd.—Automatic tuning systems. 28th May, 1954. (750133.)

16143. Fairey Aviation Co., Ltd.—Electric circuits. 10th June, 1954. (750164.)

16865. Patelhold Patentverwertungs- & Elektro-Holding Akt.-Ges.—Band-pass filters. 18th June, 1953. (750418.)

17220. Philips Electrical Industries, Ltd.—Radar navigational aid systems. 22nd June, 1953. (750327.)

17726. Electric & Musical Industries, Ltd.—Adjusting or tuning mechanisms for electron discharge devices. 15th June, 1954. (750241.)

18586. Postmaster General.—Method of, and apparatus for, electronically interpreting a pattern code. 3rd July, 1953. (750422.)

19501. British Thomson-Houston Co., Ltd.—Electric lighting fittings. 14th July, 1954. (750331.)

19525. Telephone Manufacturing Co., Ltd.—Electrical pin and socket connectors. 23rd August, 1954. (750482.)

19937. Metropolitan-Vickers Electrical Co., Ltd.—Photo-electric guard arrangements. 23rd July, 1954. (750168.)

20553. Electric & Musical Industries, Ltd.—Cathode-ray tube envelopes. 26th July, 1954. (750333.)

21548/9. General Electric Co., Ltd., and Goodman, C. H. L.—Crystal rectifiers. 4th November, 1954. (750172-3.)

21550. General Electric Co., Ltd., and Goodman, C. H. L.—Semi-conductor amplifying devices. 4th November, 1954. (750174.)

22495. Standard Telephones & Cables, Ltd.—Thermionic cathodes. 6th August, 1954. (750339.)

22654. Standard Telephones & Cables, Ltd.—Mounting of electrical components. 13th August, 1954. (750244.)

22755. Shearer, D. G.—Radio navigation system. 18th August, 1953. (750436.)

23409. Byrne, J. N.—Electrical alarms. 30th April, 1954. (750437.)

23815. English Electric Co., Ltd.—Control gear for steam turbines. 27th August, 1954. (750343.)

29710. Laboratoires R. Derveaux.—Apparatus for the remote transmission of pictures. 27th October, 1953. (750187.)

30929. Babcock & Wilcox, Ltd.—Tubulous vapour generating and superheating units and the operation thereof. 9th November, 1954. (750257.)

31507. International Business Machines Corporation.—Electronic pulse distributing circuits. 13th November, 1953. (750259.)

31907. Hoover, Ltd.—Washing machines. 15th November, 1954. (750447.)

32630. Marconi's Wireless Telegraph Co., Ltd.—V.h.f. energy absorbing or loading devices for wave guides, coaxial lines and the like. 2nd September, 1954. (750451.)

34290. British Thomson-Houston Co., Ltd.—Photo-electrically controlled apparatus. 9th December, 1953. (750452.)

34805. Carr Fastener Co., Ltd.—Electrical terminal socket contact assemblies and the method of manufacturing such assemblies. 16th November, 1954. (750370.)

35276. Lincoln Electric Co., Ltd., and Hatty, W. P. H.—A.c. arc welding equipment. 28th June, 1954. (750372.)

1954

2977. Licentia Patent-Verwaltungs-Ges.—Plate-type protective device for flameproof casings of electrical apparatus. 1st February, 1954. (750374.)

3693. British Telecommunications Research, Ltd.—Electric power supply systems. 14th January, 1955. (750270.)

4745. National Cash Register Co.—Electron tube counting circuits. 18th February, 1954. (750116.)

6517. Maul, M.—Electrical sorting machines for record cards. 5th March, 1954. (750284.)

10112. Automatic Electric Laboratories, Inc.—Stabilised oscillator. 6th April, 1954. (750469.)

11079. Skillman & Co., Pty., Ltd., T. S.—Demodulator arrangement in multi-channel carrier telephone systems. 14th April, 1954. (750380.)

16814. Pyrotenax, Ltd.—Electric cables. 31st May, 1955. (750206.)

16939. Western Electric Co., Inc.—Electromagnetic wave devices such as travelling wave tubes. 9th June, 1954. (750208.)

21382. Allmanna Svenska Elektriska Aktiebolaget.—Remote radio control system. 22nd July, 1954. (750384.)

23184. Telefunken Ges.—Radar system. 10th August, 1954. (750276.)

24003. Babcock & Wilcox, Ltd.—Tubulous vapour generating and vapour heating units. 18th August, 1954. (750277.)

NEXT WEEK'S EVENTS

Organisers of electrical functions are advised to make use of the "Electrical Review" clearing house, Room 221, Dorset House, Stamford Street, London, S.E.1, to ascertain that proposed dates for their functions do not clash with others already arranged

Monday, 11th June

LONDON.—St. Ermin's Hotel, Caxton Street, S.W.1, 6.15 p.m. A.S.E.E. Central London Branch. Annual general meeting.

WEMBLEY PARK.—Century Hotel, Forty Avenue, 7.30 p.m. A.S.E.E. North-West London Branch. Annual general meeting.

Tuesday, 12th June

BOURNEMOUTH. — Grand Hotel, Firvale Road, 7.15 p.m. A.S.E.E. Bournemouth Branch. Joint meeting and discussion with the Electrical Association for Women.

HAMMERSMITH. — Windsor Castle Hotel, 134, King Street, 7 p.m. A.S.E.E. West London Branch. Annual general meeting.

LONDON.—Caxton Hall, S.W.1, 2.30 p.m. Meeting of Electrical Engineers (A.S.E.E.) Exhibition exhibitors.

Connaught Rooms, W.C.2, 12.30 for 1 p.m. Electrical Industries Club. Monthly luncheon: Speaker, Sir Gilbert Rennie, K.C.M.G.

LUTON.—Midland Hotel, Williamson Street, 7.30 p.m. A.S.E.E. Luton Branch. Annual general meeting.

Tuesday, 12th June, to Friday, 15th June

HARROGATE.—Hotel Majestic. Association of Mining Electrical and Mechanical Engineers. Annual convention.

Wednesday, 13th June

BIRMINGHAM. — Chamber of Commerce, New Street, 6.30 p.m. A.S.E.E. Birmingham Branch. Annual general meeting.

HALIFAX.—Crown Hotel, Horton Street, 7.30 p.m. A.S.E.E. Halifax Branch. Annual general meeting.

MANCHESTER. — Women's Engineering Society, Manchester Branch. Annual general meeting at 6.30 p.m., followed by film show.

WIMBLEDON.—Guild House, 32, Worple Road, 7.15 p.m. A.S.E.E. South-West London Branch. Annual general meeting.

YORK.—Shambles Café, 7.15 p.m. A.S.E.E. York Branch. Annual general meeting.

Saturday, 16th June

OXFORD.—Y.M.C.A., 10, George Street, 7 p.m. A.S.E.E. Oxford, Reading & Districts Branch. Annual general meeting.

CONTRACT INFORMATION

Accepted Tenders and Prospective Electrical Work

CONTRACTS OPEN

Where "Contracts Open" are advertised in our "Official Notices" section the date of the issue is given in parentheses.

Australia.—10th July. Posts and Telegraphs Department. Resistors and reactances. (E.S.B. 13949/56. Ten/19648.)*

Canada.—15th June. Manitoba Hydro-Electric Board. 66,000 kW steam turbine generator sets and associated equipment. (E.S.B. 13317/56. Ten/19560.)*

22nd June. Gas turbine generators and auxiliary equipment. (E.S.B. 13722/56. Ten/19671.)*

Croydon.—22nd June. Borough Council. Street lighting equipment. (See this issue.)

Egypt.—10th July. Cairo Electricity and Gas Administration. L.v. underground cable. (E.S.B. 13599/56. Ten/19533.)*

India.—21st June. Damodar Valley Corporation Electricity Department. Instrument transformers and lightning arrestors. (E.S.B. 13792/56. Ten/19571.)* 2nd August. Control and power cables, boxes and glands. (E.S.B. 13793/56. Ten/19565.)*

19th June. Director General of Supplies and Disposals. Switchboard cable. (E.S.B. 13572/56. Ten/19529.)* 3rd July. Insulated cable. (E.S.B. 13509/56. Ten/19572.)*

20th June. Commissioners for the Port of Calcutta. Transformers, switchgear, condenser, cables, etc. (E.S.B. 13800/56. Ten/19559.)*

9th July. Bombay Electricity Board. Substation equipment. (E.S.B. 13794/56. Ten/19567.)*

25th June. Bhopal Electric Supply. Supply of material and erection of 33 kV single circuit lines. (E.S.B. 13094/56. Ten/19580.)*

20th July. India Store Department, London. Wireless set and station No. 62 and 10,500 connectors. (See this issue.)

2nd August. Posts and Telegraphs Department. Equipment for the trunk cable scheme connecting Bombay, New Delhi and Calcutta. (E.S.B. 13831/56. Ten/19616.)*

Irish Republic.—13th June. Commissioners of Public Works. Electrical installation in the turkey hatcheries, Athenry Agricultural School, Co. Galway. J. Tyrrell, secretary, Office of Public Works, 51, St. Stephens Green, Dublin.

26th July. Longford County Council. Electrical installation in sections of the new county hospital. R. B. Higgins, consulting engineer, Church Street, Longford.

Leicester.—16th June. County Education Committee. Equipment for the schools meals service for one year ending 30th September, 1957, including electric ranges and ovens, washboilers, hot cupboards, potato peelers, mixing machines, refrigerators, water heaters, etc. Director of Education, County Offices, Grey Friars.

Letchworth.—15th June. U.D.C. 123 Class "B" concrete lighting columns for 45 W sodium and 100 W tungsten street lighting units, complete with lanterns, auxiliary gear, etc., for street lighting improvements, 1956/57. E. L. Johnson, surveyor, The Council House.

Mexborough.—25th June. West Riding C.C. Rewiring of the electrical installation in Garden Street School. County architect, Bishopgarth, Westfield Road, Wakefield.

New Zealand.—13th July. General Post Office. Bituminous tape. (E.S.B. 13964/56. Ten/19606.)* Switchboard cables. (E.S.B. 13962/56. Ten/19607.)*

Northern Ireland.—15th June. Electrical installation in girls' intermediate school at Creggan, Londonderry. Varming and Mulcahy, consulting engineers, 37, Malone Road, Belfast.

31st July. Northern Ireland Hospitals Authority. Electrical works at Lurgan and Portadown Hospital. Ian Hunter & Partners, consulting engineers, 21, Botanic Avenue, Belfast.

Pakistan.—23rd June. Posts and Telegraphs Department. Low power r/t and w/t transmitters. (E.S.B. 13816/56. Ten/19593.)*

25th June. Equipment for local automatic and trunk exchange for Abbotabad. (E.S.B. 13815/56. Ten/19626.)* 26th June. 1,200 telephones. (E.S.B. 13817/56. Ten/19629.)*

Portuguese West Africa.—22nd June. Luanda Independent Light and Water Service. Electricity meters. (E.S.B. 13237/56. Ten/19549.)*

Rhodesia and Nyasaland.—15th June. Federal Tender Board. X-ray equipment and accessories. (E.S.B. 13863/56. Ten/19582.)*

South Africa.—21st June. Union Tender and Supplies Board. Insulated cable. (E.S.B. 13576/56. Ten/19532.)* Switchboard lamps. (E.S.B. 13562/56. Ten/19531.)*

22nd June. Stores Department, South African Railways. Lightning arrestors. (E.S.B. 13531/56. Ten/19515.)* Non-ferrous overhead track equipment. (E.S.B. 13547/56. Ten/19523.)* 1,920 plug-in type relays. (E.S.B. 13532/56. Ten/19520.)*

14th August. City of Cape Town. Equipment for the Athlone power station, including boiler plant, turbo-alternators, condensing plant, water pumps and pipework. (E.S.B. 13493/56. Ten/19524.)*

Stirling.—15th June. County Council. Street lighting equipment. (See this issue.)

Tangier.—Water and Electricity Board. Circuit-breakers. (E.S.B. 13380/56. Ten/19555.)* 22nd June. Five electric pump sets. (E.S.B. 13286/56. Ten/19597.)*

Thailand.—19th June. U.S. Department of Commerce, Washington. Radio transmitters, receivers and associated equipment. (E.S.B. 14035/56.I.C.A. Ten/19622.)*

* Specifications may be inspected at the Export Services Branch, Board of Trade, Lacon House, Theobald's Road, London, W.C.1 (Chancery 4411; extension 769).

ORDERS PLACED

Isle of Ely.—Education Committee. Electrical installation work at Queen's Boys' School at Wisbech (£8,524).—H. Carr.

London.—Metropolitan Water Board Works and Stores Committee. Recommended Two sets of electrically driven well pumps, including motors, motor control gear, etc., for the Southfleet pumping station (£12,823).—Harland Engineering Co.

Hammersmith Borough Council. Recommended. Electrical installation work at Lime Grove Baths (£6,610).—Bower Engineering Works (Electrical & General).

Newcastle-on-Tyne.—Regional Hospital Board. Electrical installation at diagnostic X-ray department, Middlesbrough General Hospital (£2,894).—North of England Engineering & Electrical Co. Electrical work at radiotherapy department, North Ormesby Hospital (£502).—A. Anderson & Son.

Scunthorpe.—Corporation. Recommended. Electrical wiring of 204 dwellings (£6,444).—Hobson & Scott.

Sunderland.—Newcastle-on-Tyne Regional Hospital Board. Accepted. Electrical installation works at the outpatients' department at the General Hospital (£1,398).—F. Reid Ferens & Co.

Wallasey.—Corporation Education Committee. Electrical installation work at the Moreton Secondary Modern School (£4,296).—Tom Jones (Electrical Engineers).

WORK IN PROSPECT

Particulars of new works and building schemes for the use of electrical installation contractors and traders. Publication in this ection is no guarantee that electrical work is definitely included. Alleged inaccuracies should be reported to the Editors.

Acocks Green.—Factory, Reddicap trading estate; Acocks Green Engineering Co., Ltd., 1070, Warwick Road.

Ashford (Kent).—Houses (70), Beaver Green Farm; U.D.C. surveyor, 5, North Street.

Aveley.—County technical school; A. A. Stuart & Sons, Ltd., builders, 108, Victoria Street, London, S.W.1.

Bangor (Co. Down).—Factory, Landeboye Road; H. & J. Martin, Ltd., builders, Ormeau Road, Belfast.

Barrow-in-Furness.—Police headquarters and magistrates' court, corner of Market Street and Duke Street; J. N. Flitcroft, borough engineer, Town Hall.

Bath.—Art block at Lansdown Royal School; J. Owens, city engineer, Guildhall.

Bishop Auckland.—Secondary modern school for Durham C.C.; W. and T. R. Milburn, architects, 18, Fawcett Street, Sunderland.

Bournemouth.—Tiered car park at rear of Winter Gardens; W. L. Clowes, borough surveyor, Town Hall.

Bradford.—Occupation centre for mental defectives at Bowling Hall Road (£45,000); W. H. Leathem, town clerk, Town Hall.

Brentwood.—Shops and offices, Ongar Road; A. W. Chapman & Sons, Ltd., builders, 4, Fenchurch Buildings, London, E.C.3.

Bury St. Edmunds.—Houses (116), Howard estate; Richard R. Hiles, town clerk, Borough Offices.

Chatham.—Shops and offices, High Street and Clover Street; Crusader Properties, Ltd., 38, Upper Grosvenor Street, London, W.1.

Cheltenham.—Houses (78), as redevelopment of the Tewkesbury Road/Swindon Road area; G. Gould Marsland, borough surveyor, Municipal Offices.

Cleckheaton.—Bus station, including offices, shops, etc., Dewsbury Road; Yorkshire Woollen District Transport Co., Ltd., 78, Morley Street, Bradford, and Market Shop, Cleckheaton.

Colchester.—Houses (200), community centre, school and other buildings as development of Pretty Gate estate; J. S. Orchard, borough surveyor, Town Hall.

Cumberland.—Old people's homes at Workington and Maryport; J. H. Haughan, county architect, Portland Square, Carlisle.

Dagenham.—Houses (100), Marks Gate estate; W. & J. Weatherhead, Ltd., builders, North Street, Hornchurch.

Doncaster.—Museum and art gallery (£120,000); borough architect, 15, South Parade.

Downham.—R.C. secondary school, Winlaton Road; W. H. Gaze & Sons, Ltd., builders, High Street, Kingston-on-Thames.

Duston.—Rewiring of St. Crispin's Hospital (£5,000); Northampton and District Hospital Management Committee, Northampton.

Eastbourne.—Factory on the Brampton Road trading estate for Edward E. Lazarus; H. Hubbard Ford, architect, 24a, Cornfield Road.

Edmonton.—Nine-storey block of 45 flats, Snells Park; borough architect.

Glasgow.—Fifteen-storey trades college proposed on site in the North Hanover Street/North Frederick Street site; Wylie, Shanks & Wylie, architects, 12, Claremont Gardens, C.3.

Hull.—Works and offices, South Bridge Road; A. J. Worfolk, Ltd., Queen's Dock Basin, High Street.

Health centre, Bilton Grange estate; city architect.

Ilford.—Showroom and workshops; C. W. Bunes, Ltd., Cranbrook Road.

Jarrow.—Factory for Fry's Die Castings, Ltd.; North Eastern Trading Estate, Team Valley, Gateshead.

Leatherhead.—Block of offices and shops; Invincible Policies, Ltd., motor insurance, 7, Whittington Avenue, London, E.C.3.

London.—Offices, Dowgate Hill and Upper Thames Street, City; Neish, Howell & Haldane, 47, Watling Street, E.C.4.

Jews' College, Montagu Place, Marylebone; Bovis, Ltd., builders, 1, Stanhope Gate, W.1.

Four-storey workshops, Long Street, Shoreditch; W. J. Marston & Son, Ltd., 1, Stephendale Road, S.W.6.

Offices, Wellington Street, Woolwich; Frank N. Falkner & Partners, surveyors, 39, Bedford Square, W.C.1.

Flats (112), at Dagnall Street (£241,803), Battersea, for B.C.; Rush and Tompkins, builders, 109, Station Road, Sidcup.

Central library, Holborn; borough architect.

Girls' school, St. Charles Square, Kensington; Woodcock Bros., Ltd., builders, 1, De Burgh Road, S.W.19.

Additional factory and warehouse premises, Southwark; Upsons, Ltd., 7-13, Great Dover Street, S.E.1.

Flats, 97-101, Eaton Square, Westminster; Taylor Woodrow, Ltd., builders, Adrienne Avenue, Southall.

Luton.—Cleansing depot (£100,000); borough surveyor.

Maidenhead. — Two-storey factory at Beacon Works; F. W. Charity, architect, 14, Howick Place, London, S.W.1.

Manchester.—Cinema and dance hall, Wythenshawe Civic Centre; J. Arthur Rank Organisation, 11, Belgrave Road, London, S.W.1.

Houses at Outwood Road, Cheadle (225), Kingsgate, Wythenshawe (24), Ravenscarr Crescent, Wythenshawe (32), and Stanley Grove, Longsight (6); director of housing, Town Hall, 2.

Middlesbrough.—Shops (44), Ormesby Road for Mappin Properties, Ltd., London; Manners, Hearne and Manners, estate agents, 77, Wigmore Street, London, W.1.

Houses (122), Pallister Park; J. Kenyon, borough engineer.

Milford Haven.—Dwellings (45), Mount Pleasant estate; John Bros., builders, 17, St. Annes Road.

Morpeth.—Outpatients' department at Morpeth Cottage Hospital for Newcastle Hospital Board, Benfield Road, Newcastle-on-Tyne; chief architect.

Admission hospital and two convalescent villas at St. George's Hospital for Newcastle Hospital Board (£314,000); A. R. Robertson, Ltd., contractors, East Park View, Blyth.

Newcastle-on-Tyne.—New hospital department, Middlesbrough (£90,000) and new West Cumberland Hospital, Workington; P. H. Knighton, Regional Hospital Board, Osborne Road, Newcastle.

Norwich.—Shops, with offices above (three-storey building), in Queen Street, Tombland; Woolwich Equitable Building Society, Equitable House, Woolwich, London, S.E.18.

Orpington.—Primary school, Darrick Wood; D. R. Nolans & Co., surveyors, 30, John Street, London, W.C.1.

Oxford.—Aged persons' hostel at Bayswater Road, Headington (£63,080); E. G. Chandler, city architect, Town Hall.

Portsmouth.—Works, Leigh Park industrial area; Menley & James, Ltd., 120, Coldharbour Lane, London, S.E.5.

Houses (102), West Leigh area; Auroil Builders, Ltd., Fitzherbert Road, Cosham.

New branch college at College of Technology (£258,000); J. Parkin, city engineer, 1, Clarence Parade, Southsea.

Rochdale.—St. Peter's C.E. voluntary school (£60,811); W. H. Mercer, borough surveyor, Town Hall.

Southampton.—Shops, showrooms and offices, 146, High Street, for Silver & Edgington, outfit contractors, 69, Great Queen Street, London, W.C.2; Ronald Ward & Partners, architects, 17, Lowndes Street, London, S.W.1.

Stockton-on-Tees.—Houses (600), as first development of Hardwick estate; T. H. Hartley, borough architect, 28, The Square.

Stoke-on-Trent. — Six-storey chemistry block in College Road as further stage of North Staffs Technical College extensions; director of education, Green Hall, Lichfield Road, Stafford.

Stokesley.—Houses (32); W. Burnie, R.D.C. surveyor.

Sunderland.—Houses (51), Ford estate; A. V. Clerey and Son, builders, Frederick Street.

Houses (37), High Southwick site; R. G. Finlay, Ltd., builders, Ryhope, Sunderland.

Surbiton.—Flats (54), on the Ewell Road/South Terrace area; H. B. Kingston (Builders), Ltd., West Molesey, Surrey.

Swansea.—Houses (54), Terrace Road; borough architect.

Swinton & Pendlebury.—Houses (156) and flats (16) Parkfield estate, Swinton; V. Collinge, town clerk, Town Hall, Swinton, Lancs.

Tynemouth.—Flats and maisonnettes (54); Tasker & Child, New Bridge Street, Newcastle.

Wakefield.—Houses and flats (256), Kettlethorpe estate, Area No. 4; city engineer, Town Hall.

Wallasey.—Flats and maisonnettes (178), Church Street; borough architect.

Wallsend.—R.C. church, Carville Road; Stanley Miller, 17, North Street, Newcastle.

Walsall.—Comprehensive secondary school at Lichfield Road, Bloxwich; V. Millson, director of education, Darwell Street.

Whitehaven.—Clinic and administrative buildings for Cumberland C.C. (£40,000); Thomas Armstrong, Ltd., builders, Cockermouth.

Whitley Bay.—Additions to Whitley Bay fire station for Northumberland C.C. (£30,000); Castles, Ltd., builders, Tynemouth Road, North Shields.

Houses (90), Earsdon Grange estate, for Wimpey and Co., Ltd., contractors, Orchard House, Newcastle-on-Tyne.

Church; Tasker & Child, New Bridge Street, Newcastle.

Winchester.—Bank and offices on site of old George Inn, for Barclays Bank, Ltd.; W. R. A. Curtis Green, Son & Lloyd, architects, 5, Pickering Place, St. James's, London, S.W.1.

Windsor.—Further instalment of the East Berks College of Further Education (£114,354); county architect, Wilton House, Parkside Road, Reading.

Worcester.—Regional technical college at Birdport (£500,000); director of education, 4, Copenhagen Street.

Worthing.—Shops, offices, telephone exchange, etc., as development of the Railway Approach area (£411,000); borough engineer.

Wrexham.—New science block, dining and assembly halls, handicrafts room, form rooms, etc., at Grove Park Grammar School (£24,000); county architect, Grove Park, Wrexham.

Wythenshawe (Manchester).—New general hospital; Powell and Moya, architects to Regional Hospital Board, 36, Great Smith Street, London, S.W.1.

DANISH ELECTRICAL TRADE

Denmark's electrical trade last year showed an approximate increase on the import side of 9 per cent and on the export side of 25 per cent. Imports totalled Kr.162·8 million in value and exports Kr.215·2 million, thus making the balance about 25 per cent in Denmark's favour.

The accompanying table shows the values of the chief groups in 1955 with notes of increase or decrease on 1954. It also affords a comparison of the progress respectively of imports and exports. It will be seen that imports of telegraph and telephone material doubled in value, making it the second most important item; other noteworthy increases were in radio parts and household appliances. On the other hand power plant declined although it remained the leading import, while radio transmitters decreased also.

The advance in exports was shared throughout all headings except battery parts, and was outstanding in household appliances, with a big balance in Denmark's favour. Exports of power plant increased and stood higher than imports, and cable and wire exports (the local manufacture of which has been expanded) rose to treble the import value while all the radio group showed progress.

In supplying Denmark, West Germany continued to progress and occupied first place with a total value of Kr.44·7 million; Sweden came next with Kr.32·2 million, then Holland (Kr.29·3 million) and the United Kingdom fourth (Kr.26·9 million). Denmark's chief customers were Sweden (Kr.31·7 million), Norway (Kr.25·3 million), Holland (Kr.24·8 million) and West Germany, Finland and the United Kingdom, each over Kr.11 million.

Class of Goods	IMPORTS		EXPORTS	
	1955 (000 Kr.)	Inc. or dec. on 1954 (000 Kr.)	1955 (000 Kr.)	Inc. or dec. on 1954 (000 Kr.)
Dynamos, motors, convertors, etc.	28,339	− 5,034	31,944	+ 1,415
Battery parts	1,716	+ 87	12,834	− 2,180
Incandescent lamps	8,769	− 249	457	+ 160
Radio transmitters and navigation apparatus	9,021	− 2,036	9,969	+ 4,891
Radio valves	3,283	+ 241	238	+ 142
Radio receiving sets	1,653	+ 960	3,946	+ 122
Parts for radio receiving sets	8,374	+ 2,741	22,367	+ 5,101
Telegraph and telephone material	20,930	+ 10,501	3,014	+ 504
Electrical appliances for motor vehicles, aircraft, etc.	13,786	− 3,903	1,379	+ 486
Cable and wire	4,596	− 408	14,746	+ 1,860
Electrical heating apparatus	5,130	+ 437	3,143	+ 1,060
Vacuum cleaners and other small elec. household appliances	7,485	+ 2,154	19,687	+ 7,502
Elec. measuring, controlling, signalling and alarm apparatus	8,628	+ 1,657	11,474	+ 1,251
Electromedical and rontgen apparatus	4,638	− 397	5,306	+ 1,751
Electrical material unspecified	36,477	+ 5,454	74,791	+ 19,750